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CIVIL ENGINEERING.

On Metallic Constructions. By W. FAIRBAIRN, C. E., F. R. S.*

[Paper read at the Mechanics' Institution, Manchester.]

It is nearly half a century since I first became acquainted with the engineering profession, and at that time the greater part of our mechanical operations were done by hand. On my first entrance into Manchester, there were no self-acting tools; and the whole stock of an engineering or machine establishment might be summed up in a few ill-constructed lathes, a few drills and boring machines of rude construction. Now compare any of the present works with what they were in those days, and you will find a revolution of so extraordinary a character as to appear to those unacquainted with the subject, scarcely entitled to credit. The change thus effected, and the improvements introduced into our constructive machinery, are of the highest importance; and it gives me pleasure to add, that they chiefly belong to Manchester, are of Manchester growth, and from Manchester they have had their origin. It may be interesting to know something of the art of tool-making, and of the discoveries and progress of machines, which have contributed so largely to multiply the manufactures, as well as the construction of other machines employed in practical mechanics. In Manchester, the art of calico printing was in its infancy forty years ago; the flat press, and one, or at most, two colored machines were all that were in use; the number of those machines is now greatly multiplied, and I believe some of them are capable of printing eight colors at once; and the arts of bleaching, dyeing, and finishing, have undergone equal extension and improvement. In the manufacture of steam engines there were only three or four establishments that could make them, and those were Boulton and Watt, of Soho; Fenton, Murray, and Wood, of Leeds; and Messrs. Sherratts, of this

* From the London Civil Engineer and Architect's Journal, May, 1852.

town. The engines of that day ranged from 3 up to 50, or at most, 70 horses' power; now they are made as high as 500, or in pairs from 1000 to 1200 horse. An order for a single engine at that time was considered a great work, and frequently took ten or twelve months to execute; now they are made by dozens, and that with a degree of dispatch as to render it no uncommon occurrence to see five or six engines of considerable power leave a single establishment in a month. In machine making, the same powers of production are apparent. In this department we find the same activity, the same certainty of action, and greatly increased production in the manufacture of the smaller machines, than can possibly be attained in the larger and heavier description of work. The self-acting turning, planing, grooving and slotting machines have afforded so much accuracy and facility for construction as enable the mechanical practitioner to turn, bore, and shape, with a degree of certainty almost amounting to mathematical precision. The mechanical operations of the present day could not have been accomplished at any cost thirty years ago, and what was considered impossible at that time, is now performed with a degree of intelligence and exactitude that never fail to accomplish the end in view, and reduce the most obdurate mass to the required consistency, in all those forms so strikingly exemplified in the workshops of engineers and machinists. To the intelligent and observant stranger who visits these establishments, the first thing that strikes his attention is the mechanism of the self-acting tools; the ease with which they cut the hardest iron and steel, and the mathematical accuracy with which all the parts of a machine are brought into shape. When these implements are carefully examined, it ceases to be a wonder that our steam engines and machines are so beautifully and correctly executed. We perceive the most curious and ingenious contrivances adapted to every purpose, and machinery which only required the attendance of a boy to supply the material and to apply the power, which is always at hand. This subject is an art—I would call it a science—which has occupied the attention of the greatest men from the days of Newton and Galileo, down to those of Watt and Smeaton, and it now receives attentive consideration from some of the ablest and most distinguished men of the present time. And of these I may instance Poncelet, Morni, Humboldt, Brewster, Babbage, Dr. Robison (of Armagh), Willis, and many others, to show the interest that is taken by these great men with the advancement of mechanical science. It must appear obvious to those who have studied and watched the unwearied invention and continued advancement which have signalized the exertions of our engineering and mechanical industry, that neither difficulties nor danger, however formidable, can stand against the indomitable spirit, skill, and perseverance of the English engineer; nor will it be denied, that the ingenuity and never-failing resources of our mechanical population are not only the sinews of our manufactures, railways, and steamboats, but the pride and glory of our country. A great deal has been done, but a great deal more may yet be accomplished, if by suitable instruction we carefully store the minds of our foremen and operatives with useful knowledge, and afford them those opportunities essential to its acquisition. We must try to unite theory with practice, and bring the philosopher into close contact with the practical mechanic. We must try to remove prejudices, and to encourage a sounder system of management

in the manufactures, design, and projects of the useful arts. When this is accomplished, we shall no longer witness abortions in construction, but a carefully, well digested system of operations founded on the unerring laws of physical truth.

To the student in architecture, engineering, and building, there is scarcely any acquirement more essential to professional success than a knowledge of the properties of materials which are used in construction. It is more important than either skill in design or correctness of proportion, whatever the character of the structure—be it a house, a ship, a bridge, or a machine. Before we enter upon its construction, and before we can attain a due and correct proportion of the parts, we must, as a preliminary inquiry, make ourselves acquainted with the material of which it is composed. We must study this material's powers of resistance when exposed to the varied strains of tension, torsion, and compression. We must know something of its elasticity and its powers of restoration under the strains and changes to which it may be subjected; and we must then apply that knowledge by distributing it in such form and quality as will best meet the requirements of the case, and without incurring the charge of an unnecessary or wasteful expenditure. All this knowledge appears to me to be indispensable, before we can attain anything like perfection in the art of construction; and no professor of the useful arts, whether he be an architect, engineer, or builder, can ever lay claim to sound principles of construction, unless he is acquainted with the natural properties of the material with which he deals. I shall, therefore, lay before you, in a tabulated form, a short summary of experimental facts, which you will, I think, find of some importance in their bearing upon the particular construction to which I allude.

Resisting Powers of Cast Iron.—From a number of carefully conducted experiments on cast iron, I have selected the following results. They are the highest in the order of their powers of resistance to a transverse strain, and as in each instance the bar is reduced to exactly one inch square, the results may fairly be estimated as a criterion of the resisting powers of the different irons of Great Britain:—

Transverse Strength of Cast Iron Bars, 1 inch square, 4 ft. 6 in. between the Supports

	Name and No. of Iron.		Breaking weight in lbs.	Deflexion in inches.	Power to resist Impact.
Welsh.	Ponkey,	3 C	581	1·747	992
	Beaufort,	3 H	517	1·599	807
	Beaufort,	3 C	448	1 726	747
	Mean,		515	1·691	848·6
English.	Low Moor,	2 C	472	1·852	855
	Butterley,	H	502	1·815	899
	Elscar,	2 C	427	2·224	992
	Old Park,	2 C	485	1·621	718
	Mean,		471	1·778	863·5
Scotch.	Muirkirk,	1 C	418	1.570	656
	Carron,	3 C	443	1·336	593
	Monkland,	2 H	403	1·762	709
	Gartsherrie,	3 H	447	1·557	998
	Mean,		428	1·556	739

The letters C signify cold blast; H, hot blast.

From the above, it will be perceived that the average transverse strength

of eleven specimens of English, Welsh, and Scotch iron is 471 lbs. on 1 inch square bars, 4 ft. 6 in. between the supports. These again, give a mean deflexion of 1·675 inches, and a power to resist impact of 817. Similar irons will resist a tensile strain and a crushing force per square inch as follows:—

Experimental results to determine the ultimate Powers of Resistance to a Tensile and Crushing Strain; Specimens each 1½ inch high.

Description of Iron.	Tensile strength per sq. in. of section.	Crushing strength per sq. in. of section.	Ratio of Tension to Compression.
Low Moor, No. 2	6·901 tons.	41·219 tons.	1 : 5·973
Clyde, No. 2	7·949	45·549	1 : 2·729
Blenarvon, No. 2	7·466	45·717	1 : 6·123
Brymbo, No. 3	6·923	34·356	1 : 4·963
Mean,	7·309	41·710	1 : 5·707

In the foregoing experiments, the Clyde and Blenarvon indicate the greatest powers of resistance, either as regards a tensile or a crushing strain.

In addition to the irons given above, which are those in common use, Mr. Stirling's mixed or toughened iron exhibits considerably increased powers of resistance to every description of strain when compared with the unmixed irons. Mr. Stirling has patented a process for mixing a certain portion of malleable with cast iron, and when carefully fused in the crucible, the product is equal to resist a tensile strain of nearly 11 tons per square inch, and a compressive one of upwards of 60 tons, the specimens being 1½ inch long and 1 inch square. This mixture, when judiciously managed and duly proportioned, increases the strength about one-third above that of ordinary cast iron. As the strength of wrought iron is not only a subject of great interest at the present moment, but is likely to become more so every year, I shall have to trespass longer upon your attention than may be agreeable. It is, however, imperative that I should do so, as I shall have occasion before the close of my remarks, to refer to facts, and to deduce therefrom conclusions for the elucidation and illustration of my subject. The importance of an inquiry into the art of ship building will be appreciated by you all, and when you bring to mind the dreadful casualties of navigation—the hardships of shipwreck, and the horrors of fire—you will admit the vast importance of selecting the strongest and safest materials for the construction of our ships. It is chiefly for this reason that I have selected this subject, and ventured to impose upon your attention a few dry figures, in order that you might become acquainted, first of all, with the strength and natural properties of the materials of which ships are ordinarily composed, and attach due weight to their judicious application and distribution in the attainment of a powerful, buoyant, and durable structure. I would not have ventured upon this critical and difficult subject without some practical experience, but having taken an active part, as well as a deep interest, in the earliest stages of the application of iron as a material for ship building, and having until the last two years been extensively engaged as a practical builder, I am perhaps the better able to offer a few suggestions on the advantages and superiority of iron in our war, as well as in our mercantile marine. It is well known to the public that the naval department of the

government abandoned, a few years back, (I think improperly so,) the construction of iron vessels as ships of war. The Admiralty, in my opinion, arrived at a very hasty conclusion in condemning the use of iron, after the very limited number of experiments which had been tried upon iron targets and old iron vessels as to the effects of shot. At several of these experiments I was requested to be present, and although the results were certainly unexpected, and perhaps discouraging, yet they did not, in my opinion, justify the abandonment of a material not only the strongest and lightest for such a purpose, but offering infinite security under all ordinary and many extraordinary circumstances. Even in war steamers when in action the chances are in favor of the iron ship, as it is not only secure from fire, but is much stronger, and will sustain more strain when assailed by storms and hurricanes. Steamers can back out of difficulties and dangers, when sailing vessels must remain exposed; they can assail the enemy at a great distance, and take up any position they choose; and with their great guns and long range inflict severe punishment, and do great execution without receiving a single shot. Speed being thus admitted to be an important element in our war marine, the iron ship, from its lightness and buoyancy, has another evident advantage over the wooden one, as an equal amount of power will propel it faster through the water. In the event of a war, the steam marine of this country should have great command of power, to enable the ship to manœuvre at sea with almost the same geometrical precision as a squadron of horse on parade. They should have the power to advance and retreat as circumstances may require, and the new system of tactics which eventually must come into operation, should inspire confidence in the crew as well as the commander, that the iron steamer is not only formidable but safe, as embodying all the elements of offensive and defensive warfare. In our mercantile marine we are progressing with better prospects and greater certainty; but the decision of the Admiralty to limit the construction of iron vessels in the mail and packet service is, according to my views, uncalled for, and, to say the least of it, inconsiderate. I trust the lords commissioners of the Admiralty will see the necessity, the absolute importance, of rescinding that order, and that we shall not only witness the introduction of iron for that service, but more particularly when steam power is employed in all and in every condition of an effective and a safe marine.

(To be continued.)

The Economy of Railways, as a Means of Transit, comprising the Classification of the Traffic, in Relation to the most appropriate Speeds for the Conveyance of Passengers and Merchandise. By Mr. Braithwaite Poole.*

After referring to the influence which cheap and rapid communications had on the prosperity of a nation, the author alluded to the rise of the railway system in this country, expressing the belief that it would have been economical and wise, if the legislature had in the first instance determined the lines on which the system of railways should have been constructed

* From the London Atheneum, April, 1852.

throughout the kingdom, so as to have avoided the present ruinous competition. The passenger traffic now exceeded, annually, four times the entire population of Great Britain, and was conveyed at three times the speed and one-third the fares formerly charged by the old stage or mail coaches, whilst the cost of conveyance of merchandise, minerals, and agricultural produce, had been reduced 50 per cent., as compared with the rates charged on canals and turnpike roads fifteen years ago. The ordinary fares for passengers ranged from twopence three farthings to a half penny per mile, and for merchandise from one penny to sixpence per ton per mile. The author then proceeded to consider the economy which might be introduced into the working of railways, and divided the subject into sixteen different heads, each of which referred to some particular point where it was thought a reduction of expenses might be made. The principal point advanced was, the amalgamating, or working, of all the railways in four great divisions, and insuring unity of management in every department, in the maintenance of the permanent way, and of the rolling stock, as well as in their manufacture—several improvements in the construction of the wagons being suggested. If a general classification of trains were arranged throughout the kingdom, separating each class, and running them at different speeds whenever practicable, it was thought that it would be conducive to the interest of all parties, as it was urged to be a manifest injustice towards those who paid the highest fares to find third-class passengers arriving at the same time with them. Punctuality and regularity required to be strictly attended to for the maintenance of a certain definite speed. Numerous instances were adduced to show the vast advantages and economy of the railway system, without which the penny postage could not have been achieved, or the Great Exhibition rendered available to the multitude; the produce of the land and sea, in vegetables, fruit, meat, fish, all provisions and fuel, would have remained as limited in consumption as heretofore; and the poor man's fireside in the rural districts would never have been warmed by coal.—*Proc. Inst. Civ. Eng., April* 20, 1852.

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*Cost of Locomotive Power on the Caledonian Railway.**

During the last half year, the locomotive power on the Caledonian Railway has cost, for passenger trains, 6·66d. per mile; for goods trains, 9·47d.; and for mineral trains, 7·20d.; the average being 7·61d. per mile run, against 8·47d. during the preceding half year. The expense of locomotive power and carriage stock averages 9·78 per mile, against 10·90d. at the corresponding period of the preceding year. The number of miles run with passenger trains amounts to 473,691; with goods, 296,232; and with minerals, 251,499; total, 1,021,422 miles. The number of miles run by pilot engines was 95,352. The average number of engines in working order during the half year is 107, and under repair 17. The average number of carriages in passenger trains 7, and of wagons in goods trains 24·47. The working stock consists of 73 passenger engines, 51 goods engines, 58 first class carriages, 76 second class, 108 third class, 19 com-

* From the London Practical Mechanic's Journal, May, 1852.

posite, 2 saloons, 6 post offices, 18 luggage vans, 15 carriage trucks, 15 horse boxes, 17 break wagons, 900 ordinary wagons, 52 coke, 20 covered, and 152 cattle wagons, 10 fish vans, 10 sheep wagons, 3200 mineral wagons, and 2 ale wagons.

AMERICAN PATENTS.

List of American Patents which issued from May 4th to June 1st, 1852, (*inclusive,*) *with Exemplifications by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

1. For an *Improvement in Rock Drills;* William F. Ash, Springfield, Ohio, May 4.

Claim.—"Having thus fully described the construction of my machine, what I claim therein as my invention is, in combination with the cam wheel and guide, the hanging of the lever, by which the drill is raised, on a jointed arm, so as to give it two sets of motions, viz: up and down, to lower and raise the drill, and a backward and forward motion, from and towards the cam wheel, to operate the machine without noise or jar; the whole being arranged substantially in the manner and for the purpose specially set forth and described."

2. For an *Improvement in Leather Gauges;* Lewis W. Beecher, Avon, New York, May 4.

Claim.—"What I claim as my invention is, the wheel with its inclined planes or wedges, arranged so as to act upon the roller frame, substantially in the manner herein set forth."

3. For an *Improvement in Potato Washers;* Alonzo Bentley, Honesdale, Pennsylvania, May 4.

"The nature of my invention consists in the employment of a revolving screen concentrically within a closed cylinder; the shaft of the former running through tubular projections forming the bearings of the latter; the potatoes being fed within the revolving screen, and water or steam supplied as requisite."

Claim.—"What I claim as my invention is, the screen and cylinder combined, the screen working within the cylinder, and its axis or shaft working within or through the tubular projections or bearings of the same, substantially in the manner and for the purposes set forth."

4. For an *Improvement in Lever Jacks;* Levis H. Davis, Assignor to J. A. Dugdale, Kennett's Square, Pennsylvania, May 4.

Claim.—"What I claim as my invention is, the combination of lever, the lip, and the cleat constructed as herein set forth, with the dog and the spring, so as to act together in the manner and for the purposes herein stated."

5. For an *Improvement in Electro-Magnetic Alarm Bells;* Moses G. Farmer, Salem, Massachusetts, May 4.

"My invention consists of mechanism of peculiar construction, which is put in operation by electro-magnetism, and so combined with a train of wheel work, cams, spring, weights, and a hammer, to cause successive blows to be struck upon a bell, any required number of times; the main feature of the invention consisting in this, that I am enabled, by its use, to bring into action any desirable amount of force, either of gravity, of a spring, of currents of air, or of steam, and control the duration of the same by the electro-magnet."

Claim.—"I claim as my invention, the combination, substantially as herein set forth, of the electro-magnet and armature, (or its electro-magnetic equivalent,) with the falling ball, or spring, and the detents, and the lifting cam, or its equivalents; so arranged, that

when the ball is supported by the armature, a slight force, only, of the electro-magnet, is required to trip the ball; which ball, in falling, acquires sufficient momentum to produce much greater mechanical effects than the magnet alone; the velocity of the ball, in falling, being still further accelerated by the force of a spring if desired; the power thus obtained, I use in the manner and for the purpose herein described."

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6. For an *Improvement in Washing Machines;* Christian Hollingsworth, Liberty, Indiana, May 4.

"The feature of novelty of my invention consists in the employment of balls of wood or other substance of sufficient hardness and buoyancy, which, floating in the water, in contact with the linen, the latter being worked up and down, between and among the balls, is subjected to a constantly varying and yielding rubbing pressure."

Claim.—"Having thus described the nature of my invention, what I claim therein as new is, the application, substantially as described, to the process of washing, of balls of wood, or other buoyant material, in connexion with a reciprocating frame, or equivalent device, by means of which a rolling, yielding, or evenly pressing surface is presented to the clothes, or other articles to be washed."

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7. For an *Improved Adjustable Wrench;* Andrew Hotchkiss, Sharon, Connecticut, May 4.

Claim.—"What I claim as my invention is, constructing the collar or eye of the inner jaw, with an aperture therein of greater section than the bar on which it slides, in combination with the spring therein, and the screw thereto attached; the whole constructed and operating substantially in the manner and for the purpose herein described."

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8. For an *Improvement in Differential Safety Valves;* John M'Clintic, Philadelphia, Pennsylvania, May 4.

Claim.—"Having thus fully described my improved safety valve, I would state that I do not claim constructing a valve that shall act upon the differential principle, or one which will not admit of the application of external weight or pressure; but what I do claim as new is, the peculiar arrangement and combination of the hollow cylinder box, D, sliding in case A, with the conical valve, and tubular valve rod, and escape pipe, constructed and operating substantially as in the manner and for the purpose herein fully set forth."

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9. For an *Improvement in Railroad Car Brakes;* Thomas G. McLaughlin, Kensington, Pennsylvania, May 4.

Claim.—"What I claim as my invention is, the employment of the radial bar, turning loosely on the brake lever shaft of the tender or forward car, and spring, for enabling the brakesman to operate the brake of the tender or forward car on which he is stationed, without altering the position of the radial bar after being set, as described."

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10. For an *Improved Anvil;* Charles Peters, Trenton, New Jersey, and William Fetter, Bucks County, Pennsylvania.

Claim.—"What we claim as our invention is, a cavity in the body of anvils, for the purpose of cooling the same, by the introduction of water or other fluid into the said cavity, while the faces of the said anvils are undergoing the process of tempering."

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11. For *Improved Machinery for Grinding Conical Edged Knives;* James L. Plimpton, Westfield, Massachusetts, May 4.

Claim.—"Having thus fully described the nature, construction, and operation of my invention, I will now state what I claim as new therein; I claim, 1st, the combination of the curved way and table thereon, provided with appropriate automatic contrivances for traversing the latter along the former, with the carriage on which they are both supported, and which is provided with axis and screws, or their equivalents, to adjust said carriage to any required angle with the horizon, for the purpose herein fully described.

"I claim, 2d, operating the feed motion, or the motion for carrying the edge of the knife across the periphery of the stone, by means of a roller bearing on the periphery of the stone, in the manner and for the purposes herein fully set forth.

"I claim, 3d, connecting the carriage and the table which carry the knife, with the roller receiving motion from the stone, by means of the combination of mechanism, substantially as herein described, by which the motion of the roller towards the axis of the stone, consequent upon the wear of the stone, will cause the knife or knives being ground, to follow the periphery of the stone, and thereby compensate for its wear, and preserve the required form of the edge or edges of the knives, viz: that of an arc of a circle, as herein fully set forth."

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12. For an *Improvement in Churning Machines;* Gelston Sanford, Ellenville, New York, Assignor to George A. Meacham, Enfield, Connecticut, May 4.

Claim.—"Having thus fully described my invention, what I claim therein as new is, the arrangement of dogs or pawls, J J^1, and pin *h*, with wedges K, L, for the purpose of tripping each other."

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13. For an *Improvement in Funnels;* Christen Schneider, Washington, District of Columbia, May 4.

Claim.—"What I claim as my invention is, the measuring funnel, constructed substantially as herein set forth, with an interior ventilating tube, to admit air beneath the valve."

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14. For an *Improvement in Machinery for Grinding or Polishing Saw Blades, etc.;* William Southwell, Kensington, Pennsylvania, May 4.

Claim.—"1st, The combination of two grindstones, or their equivalents, revolving in the direction herein made known, for the purpose of grinding or polishing two sides of a saw or other article, simultaneously, with a reciprocating frame, or its equivalent, for the purpose of holding the article being ground or polished, whereby the tendency of either stone to move the article is counteracted by the action of the other stone, and the same force is thereby required to reciprocate the article in either direction, as described.

"2d, The combination of the right and left hand screws, carriers, and nuts for said screws, movable pedestals or boxes, together with the cross shaft, worms, worm wheels, and handles, substantially set forth, for the purpose of moving two grindstones, or their equivalents, simultaneously against opposite sides of an article being ground or polished as described.

"3d, I do not claim giving an automatic traverse motion to grindstones; but what I do claim is, the arrangement of screws, mitre wheels, handles, eccentrics, eccentric boxes, and movable frame, substantially as herein described, whereby I am enabled, at any time, to move the grindstones, or their equivalents, entirely across the machine, for the purposes set forth, without interfering with the automatic traversing motion which is given to the said stones, irrespective of their precise position with reference to either saw frame or either saw, or other articles fixed in said frame.

"4th, The arrangement in the same machine, of two sets of reciprocating frames, either of which can be stopped without affecting the other, and a carriage, whereby the grindstones can be caused to move from one frame to the other; by which arrangement one saw can be ground or polished, while another is being adjusted into place."

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15. For an *Improvement in Lightning Rods;* James Spratt, Cincinnati, Ohio, May 4.

Claim.—"Having thus fully described the nature of my improvement, what I claim therein as new is, the formation of the point of a lightning rod, of three or more metals, encased one within another, the most fusible to the outside, in order to prevent the destruction of the entire point, by melting from an overcharge of the electric fluid."

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16. For an *Improvement in Window-Blind Machinery;* Daniel H. Thompson, Springfield, Massachusetts, May 4.

Claim.—"Having described the nature, construction, and operation of my invention, I will proceed to state what I claim. I claim, 1st, Hanging the auger shaft in swinging

arms or gates of different lengths, hung on centres, said centres being in line, so that by moving the said swinging arms or gates nearer to or further from a position at right angles to the line in which the centres are placed, the distance between the said auger shafts, taken in lines parallel to the line of centres, will be increased or decreased, and thereby be adjusted to different widths of slats lying upon each other, as herein substantially set forth.

"I claim, 2d, The combination of the sliding bar or carriage, carrying the stiles and rods, with the reciprocating carriage, carrying the mortising augers and wire hole pickers, in the manner substantially as described, for the purpose of boring the mortises in the slats, and pricking the wire holes in the rods, and ensuring the distances between the mortises and points of attachment of the slats being precisely the same throughout.

"I claim, 3d, The reciprocating slat table, or bed, made in three parts, X, Y, Y^5, the two end parts of which are adjustable to the middle part, in combination, substantially in the manner described, with the adjustable cutter heads, to wit: the end parts Y, Y^5, of the table or bed, and the cutter heads being adjustable, relatively to each other, for the purpose of tenoning or turning down the pivots on both ends of slats of various lengths.

"I claim, 4th, Pricking the wire holes in the slats, and feeding them at proper intervals from the box in which they are contained, to the bed or table upon which they are tenoned, by means of a vibrating feeder, deriving its motion from the bed or table carrying the slats, the said feeder being provided with suitable horns, or their equivalents, and prickers, for the purpose of entering the box, and pricking and pushing out the slats one after the other, in succession."

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17. For an *Improvement in Speaking Tubes;* Thos. J. Woolcocks and Wm. Ostrander, City of New York, May 4.

Ceaim.—"What we claim as of our invention is, the combination of an alarm valve with a speaking tube, or pipe, in the manner and for the purpose substantially as herein set forth."

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18. For a *Blind and Shutter Fastener;* Samuel Barker, City of New York, May 11.

"The nature of my invention consists in securing or fastening shutters, by having the upper portion of the pintle of the hinge of a square or many sided form, and the upper part of the socket (its inner surface) of a corresponding figure, a space being between the upper portions of the socket and pintle; a cap corresponding in form to the upper portions of the socket and pintle, fits over the pintle, and prevents the socket from turning around it, and consequently the shutters from swinging."

Claim.—"What I claim as new is, the method of securing or fastening window shutters, by having the upper portion of the pintle of the hinge of a square or other many sided form, and the upper portion of the socket of a corresponding shape, a space being between the socket and pintle, to receive the cap, which corresponds in shape to the upper portion of the pintle and socket, and fits on the pintle and in the socket, securing or fastening the shutter, as herein specified."

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19. For an *Improvement in Portable Cot Bedsteads;* William C. Betts, City of New York, May 11.

Claim.—"What I claim as my invention is, 1st, The elevation in the side rails, as a substitute for the pillow, as described.

"2d, I also claim the dovetails, as used, for attaching and detaching the legs to and from the side rails, that is to say, the dovetails entering their mortises from opposite ends of the cot frame, so that they cannot readily loosen by use.

"3d, I also claim the arrangement of the right and left hand screws, which unite the opposite legs at their crossings, in such a manner that the screws shall tend to tighten the joint as the legs separate from each other, or loosen the same as they approximate.

"4th, I claim the combination of the tense bars, having right and left screws, with the side rails of a cot bed, for the purpose of keeping the sacking bottom tense."

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20. For an *Improvement in Railroad Car Seats;* Abel B. Buell, Westmoreland, New York, May 11.

"The nature of my invention consists in attaching to the backs of the ordinary car seats, outer sliding backs, which may be raised or lowered, as required."

Claim.—"What I claim as my invention is, constructing the backs of railroad car seats with outer sliding backs, fitting in slides, and held by springs, for the purpose of elevation above the ordinary back, or depression below it, as herein shown and set forth."

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21. For an *Improvement in Meat Cutters;* William Burns, Rome, Ohio, May 11.

Claim.—"I am aware that most of the parts contained in this description of my improved sausage machine are not in themselves, separately considered, novel; but that they are, singly, or more or less connectively, in similar machines, been employed or patented, such as a cylinder armed with knives, and rotating within a concave, the frame having a feed opening and a discharging channel, and the gearing for imparting to the cylinders a rotary motion. I therefore do not claim as new any of these parts separately considered, or irrespective of the manner or arrangement in which I propose, in combination, to apply them for the purposes and to produce the advantages specified.

"But what I do claim as new is, arranging in separate concaves, maintaining vertical positions and uniting with each other, two cylinders, the one above the other; the upper one operating to partially mince the meat, and deliver it upon the lower cylinder, revolving at a greater speed, for reducing it to the required fineness, as described."

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22. For an *Improvement in Measuring Faucets;* Jacob R. Byler and George W. Sensenich, Beartown, Pennsylvania, May 11.

"The nature of my invention consists in so forming a measuring and drawing faucet, as that it shall always be filled with the fluid or liquid to be drawn, and so that it may be forced or drawn out of the faucet at any time and immediately, without awaiting the sluggish movement of such articles as above mentioned."

Claim.—"What we claim therein as new is, the so constructing of a faucet for measuring and drawing molasses, honey, oil, tar, or other liquids, as that they shall always stand charged with a measured quantity of the liquid, which may be forced out of the faucet instantaneously, however thick or sluggish it may be, when the same is accomplished by means substantially the same as herein described and represented."

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23. For an *Improvement in the Manufacture of Brushes;* Abbot R. Davis, East Cambridge, Massachusetts, May 11.

Claim.—"I claim as my invention the above described improvement in filling the holes of a brush-block with bristles, the same consisting in the employment of a frame to contain said bristles in mass, and hold them in the brush-blocks, and in the direction of their respective holes in the block, in combination with giving to such block and frame such movements, rappings, jarrings, or blows, as to cause the bristles, by the force of gravity or concussion, to pass into and fill the holes in the block, as hereinbefore stated."

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24. For an *Improvement in Cooking Boilers;* L. S. De Bibory, Baltimore, Maryland, May 11.

Claim.—"What I claim as my invention is, the application of the small cup to the cooking pot, as herein described."

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25. For an *Improvement in Apparatus for Soldering in a Vacuum;* Joseph B. and John R. Horne, Xenia, Ohio, May 11.

Claim.—"What we claim therein as new is, the application to the purpose of soldering in vacuum, of a hollow bent tube for the reception of a heater, the said tube being closed at the lower end, and provided with a screw-thread at its upper end, fitting tightly within a screw neck or collar upon the glass receiver of an ordinary air pump, or other suitable instrument for producing a vacuum, the bent form of the tube bringing it to bear, during its rotation, upon the perimeter of the circular disk which closes the aperture."

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26. For an *Improvement in Blocks for Printing Oil Cloths;* James Jenkins, Elizabethtown, New Jersey, May 11.

"The nature of my invention consists in attaching to two of the corners of wooden pat-

tern blocks, a gauge, admitting of adjustment to accommodate the expansion and contraction of the wood; also, by means of horizontal pitch points, (formed of a screw working in a collar on the gauge,) adjusting the parallelism of the edge of the block and face of the stock, enables the printer more accurately and expeditiously match the block, or as it is technically termed, register."

Claim.—"Having described the nature and operation of my invention, I do not claim the construction of the stock or gauges thereon; but what I do claim as new is, the movable gauge, in combination with the adjustable point, or its equivalent, to compensate for the contraction and expansion of the pattern block, in the manner and for the purpose substantially shown and described."

27. For an *Improvement in Platform Scales;* Robert Newell, Lebanon, Indiana, May 11.

Claim.—"What I claim as new in the above described scale or balance is, the rod, *r*, and the rod and socket, *w*, and sector, *z*, or their equivalents, in combination with the revolving head and face, (or graduated plate,) and hand or index, to show at once, and in any required direction, the weight of the article weighed."

28. For an *Improvement in Lead Pipe Machinery;* Benjamin Tatham, City of New York, May 11.

"My said invention is an improvement upon the method of making pipes from set or solid lead, described in the specification of a patent granted to Thomas Burr, of Shrewsbury, in Shropshire, England, dated the 11th day of April, A. D. 1820."

Claim.—"I am aware that the invention of this machinery describes the core as being forced to the centre of the die, and retained there by the pressure of the issuing pipe; and therefore I do not claim, broadly, having the core so that it shall not be affected by the vibrations of the ram.

"What I do claim as my invention is, connecting the core with the ram, by means of an universal joint, or its equivalent, substantially as specified, so that the core shall be retracted with the ram, in combination with the cylinder and die of a machine for making pipe by pressure, from lead or other soft metal, ran into the cylinder and on to the said core in the molten state, substantially as specified, whereby the core is retracted with the ram, and held in position while the charge is poured in, and during the operation of forming the pipe, the vibrations of the ram do not practically affect the central position of the core in the dies, as herein specified."

29. For an *Improvement in Tables;* Timothy H. Taylor, Fayetteville, New York, May 11.

Claim.—"I claim, 1st, The employment of flies, *g g*, levers, *h h*, or their equivalents, in combination with the spiral springs, *e*, or their equivalents; the whole being constructed and arranged and operating in the manner and for the purposes substantially as herein set forth.

"2d, The employment in the manner substantially as herein described, of the levers, *h h*, or their equivalents, in combination with the flies, *g g*, for the purpose of lowering the table leaves when desired."

30. For an *Improvement in Gold Beating Machinery;* William Vine, Hartford, Connecticut, May 11.

"The nature of my invention consists in the combination of a cam, or its equivalent, so constructed as to be of a double form and action, with a rod sliding through a cylinde which is provided with a pivot, so that it is free to move horizontally, said rod giving the appropriate movement to the packet, and the object of the invention being to give to said packet motions in two directions with only one cam."

Claim.—"What I claim as my invention and improvement is, the double action adjustable, differential cams, or their equivalent, combined with the sliding rod and pivoted cylinder, in connexion with other parts of gold beating machinery, substantially in the manner and for the purpose as herein set forth and described."

31. For an *Improvement in Mash Tuns;* Robert Wicks and James Faulkner, Jr., Williamsburg, New York, May 11.

"The nature of our invention for cooling the contents of the mash tun, consists in ap-

plying the top, bottom, and sides of the tun with sufficient water, until the enclosed mash is reduced to the proper temperature."

Claim.—"What we claim as our invention is, the completely enveloping the mash tun with water, or sufficiently so to produce the desired rapidity in cooling the mash."

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32. For an *Improved Implement for Cutting Butter from Firkins;* Nathaniel Woodbury, Salem, Massachusetts, May 11.

Claim.—"What I claim as new is, the knife operated by means of the levers, or their equivalents, in combination with the piston, and the box, the knife, levers, and piston being constructed, arranged, and operated in the manner and for the purpose substantially as herein shown and described."

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33. For an *Improvement in Carding, by which Variegated Slivers are Produced;* Jonas Holmes and Ephraim French, Lee, Massachusetts, May 18.

Claim.—"What we claim as our invention and improvement is, traversing the doffer or doffers of a card, or setting the teeth upon them, serpentine or zig-zag, or serpentine and zigzag, or in such other curves, points, or angles, as may suit the taste or fancy of the operator; also to traverse them when so set, if desirable, so as to take the wool or other materials, from such parts of the main or other cylinder of the card, and deliver it to the condensing rollers or other apparatus, so as to make roving variegated, either in colors, or materials, or both, when said colors or materials are fed upon the card, substantially as described."

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34. For an *Improvement in Stoves;* George W. Kennison, Newburyport, Massachusetts, May 18.

"In a stove constructed on my improved plan, a most perfect control of the draft and consumption of the coal is attained, with a distribution of radiated heat, that renders the stove very pleasant and agreeable in its effects on the air (of the apartments) that impinges against the external surface of the drum."

Claim.—"It is therefore that my invention, and what I claim, consists in a combination of the following particulars, or elements, viz: 1st, A close drum or chamber, made with one or more air inlets, and their closing slides or doors in the lower part, and a fuel opening and door, at or near its upper part.

"2d, A fire pot or chamber of combustion, placed within the said drum, and having a grate in its lower part, and a smoke discharge pipe leading out of it, at or near its upper part.

"3d, An air space under the fire pot grate.

"4th, A space between the external sides of the fire pot and the internal sides of the drum, and made to freely communicate with the space under the grate.

"5th, A space above the fire pot, or place for the fuel, and made to freely communicate with the space around the fire pot.

"6th, A fuel supply opening and door, and an air register in the top of the fire pot; the whole being arranged and made to operate together substantially as above described."

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35. For an *Improved Ships' Block;* Charles H. Platt, City of New York, May 18.

"The nature of my invention consists in encompassing the cheeks of the block with metal hoops or bands, which fit in grooves in the peripheries of the cheeks; said hoops or bands being bent at the upper end or part of the block, so as to form eyes, through which a bolt passes which secures the cheeks the proper distance apart at the upper end."

Claim.—"I do not claim the metal plate for connecting the cheeks, for that has been previously employed; but what I claim as new is, the employment or use of the metal bands or hoops; said hoops or bands encompassing the cheeks, and fitting in grooves in the peripheries of the cheeks, the hoops or bands having eyes formed in them at the upper end of the block through which the bolt passes, securing the cheeks the proper distance apart at the upper end of the block, as set forth."

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36. For an *Improvement in Umbrellas;* J. V. Tibbets, City of New York, May 18.

"The nature of my invention consists in having a certain number of steel rods brought

to a spring temper, and attached at their tops, either by springs or joints, to a slide; said slide being placed upon a vertical rod; this forms the frame."

Claim.—"Having thus described my invention, and the manner of using the same, I wish to state that I do not lay special claim to the device consisting of a female screw slide, working over or on a screw rod, and operating together, for opening and closing the frame of the umbrella, as the devices to effect this may be varied; but what I do claim as my improvement is, distending or opening the umbrella, by the rods which have heretofore simply served as stays to the covering, and been permanently attached thereto; the covering being secured to the apex of the central rod, and the lower ends of the distending rods; and this I claim, whether the inner ends of the distending rods be made to descend, or the central rod to ascend with the apex of the covering, in distending the umbrella.

"I also claim the manner of securing the cover to the frame, viz: by means of swivels attached to the cover, and screwed into the ends of the rods, as herein described.

"I also claim the application of the springs of the rods F, to the slide E, operating in the manner and for the purpose described."

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37. For *Improvements in Iron Safes;* William Alford and John D. Spear, District of Southwark, Pennsylvania, May 18.

Claim.—"What we claim as our discovery, invention, and improvement is, the application of chalk, or whiting, which has been subjected to the action of acids, and has been partially deprived of the carbonic acid, the material which we use being in fact the waste or residual matter, left from the manufacture of what is called mineral water, after chalk or whiting has been subjected to the action of acids, for the purpose of expelling a portion of its carbonic acid; this residual matter consisting substantially of the substances named in the analysis before referred to, in the construction of double iron chests, or safes, in the manner above described, or in any other manner substantially the same."

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38. For an *Improvement in Saw Sets;* Asahel G. Bachelder, Lowell, Massachusetts, May 18.

Claim.—"What I claim as my invention is, the dog or set, J, so constructed and arranged, as to traverse or slide upon a rod or bar, in a direction parallel to the toothed edge of the saw, for the purpose of setting the same, substantially as described."

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39. For an *Improvement in Straining Saws in Saw Mills;* Edm. Booth, Philadelphia, May 18.

"The nature of my invention consists in the employment of a lever, passing through and working freely in, and up and down an oblong slot, cut in a vertical post secured to the top, and nearly in the centre of the saw mill. This lever is attached at one end, near its fulcrum, to a rod or link, which connects it to a spring secured to the top of the saw mill, and the other end is inserted into the upper guide rod of the saw, and works in a slot in the same."

Claim.—"What I claim as new is, the employment of the lever, or its equivalent, the spring connected to the lever by a rod or link, which is secured or attached to the lever, near its fulcrum, both operating together and in combination with a reciprocating saw, connected to the lever, and the whole being constructed and arranged and operating substantially as herein described."

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40. For an *Improvement in Cartridges for Breech Loading Guns;* Wm. W. Marston, and Frederick Goodell, City of New York, May 18.

Claim.—"We do not claim to have invented any of the separate parts described herein; but we do claim as new and of our own invention, the application of the leather breech piece to cartridges used with breech loading guns, such leather breech piece serving the purposes of a foundation for its own cartridge, a protection to the breech pin, a wad for the next cartridge in succession, and of a swab to clean out the soilage caused in the barrel by the antecedent explosion, producing a safe cartridge for pieces that load at the back of the breech, and in which explosion is also caused in the line of the axis of the barrel, substantially as described and shown, but without regard to the sizes of arms

used with these cartridges, and irrespective of the machinery, or mechanical means, by which the cartridge itself is made."

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41. For an *Improvement in Swings;* Edward Maynard, City of New York, May 18.

Claim.—"Having thus fully described my invention, what I claim is, the combination of the wire frames, constructed as set forth, with the net work and swing cords."

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42. For an *Improvement in Cotton Batting;* E. P. Rider, Brooklyn, New York, May 18.

Claim.—"Having thus described my invention, what I claim as new is, uniting two or more layers of cotton batting together, by means of any glazing material, thereby producing a new article of manufacture, which I term cotton felt, to be used for upholstery and all other purposes to which it is applicable, as herein set forth."

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43. For an *Improvement in Churns;* Clarkson Rhodes, Morrow, Ohio, May 18.

"The nature of my invention consists in the manner I work the beaters or dashers, by a double belt cranked shaft, together with the method I employ, to suspend said beaters or dashers on their fulcrums."

Claim.—"What I claim as my improvement is, hanging the series of beaters or dashers by rods, extending from the shaft, the lower end of which rods supports the fulcrum, on which the beaters or dashers move, (not confining myself to the number or form of the dashers,) the said dashers being operated by the rods and bell cranks, substantially as herein forth."

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44. For an *Improvement in Ovens;* Thomas N. Reid, Baltimore, Maryland, May 18.

"My invention consists in furnishing an oven, with all the characteristics of a baker's oven, with the addition of such fixtures as are necessary for cooking, heating water and air for household purposes; the utility of an oven of brick, such as used by professional bakers, heated conveniently, need not here be enumerated, while the advantages of combining therewith, cooking apparatus for domestic use, are incalculable."

Claim.—"Having thus fully described my improved oven, with cooking apparatus attached, what I claim therein as my invention is, the construction of said oven, with recesses on the side or sides for fuel, substantially as set forth above, and in combination therewith, the cooking chambers as herein described."

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45. For an *Improvement in Hay Rakes;* Charles R. Soule, Fairfield, Vermont, May 18.

Claim.—"What I claim as my invention is, so constructing revolving spring tooth rakes, as to bring the centre of revolution nearer the lower ends of the teeth, than can be done by having them revolve on the head around which the teeth are coiled, (which is the usual mode,) by which means I cause them to revolve much quicker, and in going a much shorter distance than otherwise can be done; while at the same time they revolve much easier and more readily, in consequence of having the second head, coil, &c., to balance, or nearly so, the remaining heft of the teeth, &c., which will be on the other side of the centre of revolution, or nearly so; thereby giving the required length and elasticity to the teeth, with a quick and easy revolution, which I accomplish as herein set forth, or by means analogous thereto."

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46. For an *Improvement in Cements;* B. S. Welch, Brooklyn, New York, May 18.

Claim.—"Having thus described my invention, I claim the primary cement herein described, formed of the hydrate of lime, in a finely subdivided state, and resin in a finely subdivided state, mixed together with water in a cold state, for the purpose set forth."

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47. For an *Improvement in Machines for Making Fuses;* Albert F. Andrews, Avon, Connecticut, May 25.

Claim.—"What I claim as my invention is, passing the hollow mandrel through the winding spools, in combination with the flyers, which direct the winding thread from the

different spools to the interior of said mandrel, for the purpose of winding the fuse as it passes from the forming machine, when combined substantially as herein described."

48. For an *Improvement in Locomotive Boilers;* James W. Farrel, Reading, Pennsylvania, May 18.

Claim.—"What I claim as my invention is, isolating the lower portion of the water space surrounding the furnace from the upper portion, and connecting it by a free and constantly open communication with the tank of feed water, in such manner that the feed water of the tank will circulate without being forced by a pump in contact with the fire plates, to cool them, and to be itself heated, preparatory to being pumped into the boiler, substantially as herein set forth."

49. For *Improvements in the Tumblers of Locks;* Henry Blakely, City of New York, May 25.

"My invention consists in an improved construction of tumbler locks, and in the manner of operating them; in the finer sort, those intended for affording the greatest possible security, very skilful workmanship is required to obtain that extreme accuracy in the construction of the various parts which is essential to their successful operation."

Claim.—"What I claim as of my own invention is, firstly, the employment of tumblers in such combination with the bolt of the lock, that each and every tumbler, independent of the others, shall have freedom to move laterally, as well as vertically, whereby a great number of positions may be assumed by their unattached ends as described.

"Secondly, I claim the guide pieces upon the key, for the purpose of controlling the lateral motion of the tumblers as described; the whole being constructed and operating, substantially in the manner and for the purpose herein set forth and described."

50. For an *Improvement in Watch Chain Swivels;* W. B. Carpenter, Assignor to W. D. Salisbury and S. Y. D. Arrowsmith, City of New York, May 25.

Claim.—"What I claim as my invention is, making the joint of the opening piece *i*, oblique to the eye, so that it will open obliquely to the hook piece *a*, or *b*, in the manner and for the purpose herein set forth."

51. For an *Improvement in Mortising Machines;* John B. Chambers, Pittsburg, Pennsylvania, May 25.

Claim.—"Having fully described my several improvements, and sufficiently so for the better illustration of the former, the parts (not new) connected therewith, and constituting in combination the machine, I desire it to be understood that the main principle of action involving reciprocating chisels, and by a ratchet wheel feeding on the timber, is not by any means new; nor do I claim such, these being well known and common to other mortising machines; nor yet do I claim reversing the chisel; neither do I claim, separately of themselves, the device by which I effect my improvements: but what I do claim as my invention is, 1st, the employment of a stop catch, or hook, operated on by the reach arm, or pawl, to prevent the momentum given to the ratchet wheel from throwing the pawl out from between the teeth, after having performed its pull, and so making irregular the feed, one of the ratchet wheel teeth being beveled or reduced, in order to admit of the pawl entering sufficiently deep to arrest the motion of the feed, in the manner and for the purpose set forth.

"2d, The combination and arrangement of the stud, clutch arm, lever, cam, and stop, so that when the lever is thrown in, the cam will unclutch the machine, when the chisel crank is on the full centre, and the chisels are out of the work, and retain them in that position by the clutch coming in contact with the stop; the several parts being made, arranged, and operated in the manner herein fully set forth."

52. For an *Improvement in Stone Dressing Machines;* Simon W. and Reuben M. Draper, Boxborough, Massachusetts, May 25.

Claim.—"What we claim as our invention is, hanging the arm carrying the pick upon

a shaft, which receives a vibratory motion through a cam, driven by a mill spindle, or other spindle provided for the purpose, and giving the said arm a motion lengthwise along the said shaft, substantially as and for the purpose herein described."

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53. For an *Improvement in Swivel Hooks;* Albert and Morris Falkenau and Moris Pollak, City of New York, May 25.

Claim.—"We do not claim to have invented any one of the parts described and shown, as these in themselves, separately, are not new; but we do claim the combination of the spring, and its inclosing slide, with a swivel hook, for the purposes and as described and shown."

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54. For an *Improvement in Worm Tubs for Stills;* George Johnston, Farmington, Iowa, May 25.

Claim.—"What I claim as my invention is, the division of the worm tub into an upper and a lower compartment, and connecting them to each other by a valve, so arranged that it will be operated by the influence of the temperature of the water in the upper compartment, for the purpose of enabling the distiller to keep the water in the said upper compartment at any elevated temperature that may be required for use, in preparing the distiller's beer, or fermented wash, or for other purposes in the distillery."

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55. For an *Improvement in Flour Bolts;* David Marsh, Fairfield, Connecticut, May 25.

Claim.—"I do not claim to be the first to use a flat sieve or bolter, to separate substances of different sizes; what I do claim as new and of my own invention is, the construction, arrangement, and combination of the shafts and cranks 3 and 6, to receive and move the bolter *c*, with the cranks 7 and 8, and connecting bar *a*, or their equivalents, as described, to regulate and equalize the movement, the coarser particles being carried off from the bolter *c*, by the flexible tube *f*, or other convenient means; the whole being substantially as described and shown.

"And I claim the application of the breakers or spreaders *d*, in the bolting box *c*, to prevent the material working off too fast, and spread it evenly over the sieve or bolter *c*, as described and shown."

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56. For an *Improvement in Lubricating Oils;* William H. Mason, Boston, Massachusetts, May 25.

Claim.—"Having described the character of my invention, I will state that I am aware that spirits of turpentine and carbonate of potash have been used before my invention, in lubricating compounds, and I do not, therefore, claim them, except as specific agents to accomplish a definite and specific purpose stated in the specification; what I claim as my invention is, the combination of a mixture of camphene and benzole, carbonate of potash and glycerine, with whale or other cheap oil having similar properties, in the manner and for the purposes set forth."

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57. For an *Improvement in Hominy Machines;* Samuel Hull, Carroll County, Maryland, May 25.

Claim.—"What I claim by my invention is, the combination of the beaters *c*, *c*, with the beaters D D, each set moving in opposite directions, as set forth in the foregoing specification, substantially and for the purposes therein noticed."

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58. For an *Improvement in Railroad Car Trucks and Brakes;* E. G. Otis, Bergen, New Jersey, May 25.

Claim.—"I do not claim the winding of the chain around the axle, for the purpose of pressing the shoes against the wheels; neither do I claim the clutch, nor the collar, separately, for they have each been previously used; but what I do claim is, 1st, the method of operating the toggle joint, by means of the rod, having the cam upon it, which works in a slot in the bar, by which the clutch is thrown in and out of gear, or the cap made to

bear against the hub of the wheel, in combination with the compensating joints constructed in the manner and for the purpose as shown and described.

"2d, I claim the employment of the guards, vertical studs, and rods, arranged as described, for the purpose of enclosing the wheels and prevent them getting off the track, in case of the breakage of a wheel or axle, in combination with the arms and bolts, by which the trucks are suspended to the car bed, in the manner and for the purpose as herein specified."

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59. For an *Improvement in Cooking Apparatus;* Joseph Smolinski, City of New York, May 25.

"The points in which I claim to have made improvements are, the enveloping the centre of the stove or furnace, (as, for instance, the oven, or place for cooking,) with the smoke flues, carrying them up and down upon each side, and above and beneath, so that all the caloric in the smoke may be absorbed, before it passes out at the chimney; and, secondly, the combining with the stove, an easy and efficient mode of ventilation."

Claim.—"What I claim as my invention is, 1st, The peculiar arrangement of the smoke flues, as shown in figures 13 and 14, by which they are made to envelope the centre on all sides, and thus concentrate them in the smallest possible space.

"2d, The combination with this machine, of the key and valves, for ventilation and supply of air to the furnace from the room as above described."

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60. For an *Improvement in Cast Iron Car Wheels;* Stephen Thurston, Scranton, Pennsylvania, May 25.

"This invention consists in connecting the hub and rim, by a single plate of a peculiar form, which I consider well adapted to stand the shrinkage, in cooling, and to withstand the jarring to which all wheels are subject in running, and which presents no difficulties in moulding."

Claim.—What I claim as my invention is, constructing the hub and rim of a solid cast iron railroad wheel, by a single plate, having two series of radial corrugations, substantially as herein described."

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61. For an *Improvement in Machines for Jointing Staves;* Dennison Woodcock, Independence Centre, New York, May 25.

Claim.—"What I claim as my invention is, jointing the staves by means of cutters set at an inclined position, and converging towards one another in the front, the said cutters having a motion given them perpendicular to the stave, for formation of the bilge, or varying width of the stave, by means of the cam, the framing, and their accompanying parts, or devices equivalent thereto, operating substantially as specified."

Re-issue for May, 1852.

1. For an *Improvement in Apparatus for Parti-Coloring Yarn;* Alexander Smith, West Farms, New York; dated June 18, 1850; re-issued May 11, 1852.

Claim.—"What I claim as my invention is, the method substantially as specified, of parti-coloring yarns that have been reeled by direct and free immersion by means of frames carrying the reeled yarns, and combined with the vat containing the dying liquor, by means of machinery adapted to let down and draw up the said frame, and measure the extent of immersion, substantially as set forth.

"I also claim, connecting one or both of the reels in each frame by means of slides, to admit of removing the reel from contact with the yarns, whilst in the process of dying, substantially as specified."

Designs for May, 1852.

1. For a *Design for a Cooking Stove;* Apollos Richmond, Assignor to A. C. Barstow & Co., Providence, Rhode Island, May 11.

Claim.—"What I claim as my production is, the new design, consisting of the ornamental sheaf work, vine and flower work, &c., herein above described and represented in the drawings, for the front, side, and back plates of a cooking stove."

2. For a *Design for a Cooking Stove;* Hosea H. Huntley, Assignor to David D. Woodrow, Cincinnati, Ohio, May 11.

Claim.—"What I claim as my invention is, the design and configuration of the ornamental stove, all in combination, as herein substantially specified and represented in the accompanying drawings."

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3. For a *Design for Cook Stoves;* Thomas A. Herrick, Boston, Assignor to Lemuel M. Leonard, Taunton, Massachusetts, May 18.

Claim.—"What I claim as my production is, the new design, consisting of the ornamental mouldings, ribs, and rays, herein above described and represented in the drawings, for the side plate of a cooking stove."

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4. For a *Design for a Cook Stove;* Nicholas S. Vedder and William L. Sanderson, Troy, Assignors to Peter J. Clute, Schenectady, New York, May 18.

Claim.—"What we claim as new is, the ornamental design and configuration of cook stove, the same as herein described and represented in the annexed drawing."

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5. For a *Design for Ladies' Hair Combs;* William Redheffer, District of Spring Garden, Pennsylvania, May 25.

Claim.—"What I claim as my invention is, the design and configuration of fancy combs, above described."

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6. For a *Design for a Towel Stand;* Nathaniel Waterman, Boston, Massachusetts, May 25.

Claim.—"I claim the ornamental design or configuration, substantially as represented in the drawings."

JUNE, 1852.

1. For an *Improvement in Fountain Pens Holder;* Charles Cleveland, Middlebury, Vermont, June 1.

"By this improvement the inconvenience and interruption of dipping the pen in ink is avoided; and the pen, with a supply of ink in the fountain, can be kept in the pocket, ready for use, occupying no more space than the ordinary pen and holder."

Claim.—"What I claim as my invention is, the combination of the valves in a fountain pen, for the admission of air, and regulating the flow of ink, with the slide or buttons, and with the spring and slide, in the manner above described, or in any other substantially the same."

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2. For an *Improvement in Corn Shellers;* David Eldridge, Philadelphia, Pennsylvania, June 1.

Claim.—"What I claim as new and my improvement is, the combination of the conical concave wedge and the guard with the concave wheel, for shelling corn, as herein described."

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3. For an *Improvement in Railroad Car Wheels;* Nehemiah Hodge, North Adams, Massachusetts, June 1.

Claim.—"What I claim as new is, the construction of car wheels, the combination of the segmental ring and keys, constructed substantially as described, or their equivalents, for the purpose of facilitating the insertion of the ring or band of india rubber, or other elastic material, between the central portion and the rim of the wheel, and as a means of fastening or holding the whole together, as herein set forth and shown."

4. For *Improvements in Copying Manuscript;* John Jones, Clyde, New York, June 1.

Claim.—"What I claim as new is, 1st, The employment or use of the circular rack, which serves as a guide to the index, said rack having a rim attached to its under surface, and projecting outwards, with the necessary letters and characters stamped or placed upon it, corresponding to the type placed on the periphery of the horizontal wheel, as specified.

"2d, I claim placing or securing the type vertically to the periphery of a horizontal wheel, having a rotating motion, and also a motion in the direction of its axis, by which, with the aid of the rack and index, the required letters may be printed upon the paper, in combination with the roller, the levers, and the shaft, or other equivalent device, for the purpose of operating upon the cylinder and adjusting it, to allow for the different thickness of type on the wheel, as herein described.

"3d, I claim the employment of the cylinder upon which the paper is secured, said cylinder having a motion in the direction of its axis, and also a rotating motion, said motions being communicated to it by the devices as shown and described, or in any other equivalent manner."

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5. For *Improvements in Violins;* William S. Mount, Stony Brook, New York, June 1.

Claim.—"That which I claim as my improvement is, the construction of that portion of stringed musical instruments which receives the strain of the strings, when tightened in tuning, in such form or forms as will cause the line of that portion of the instrument to be lengthened instead of shortened, if the same be altered at all by the strain.

"I also claim the hollow backed violin, or other stringed musical instrument of similar character, constructed substantially in the manner herein set forth."

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6. For an *Improvement in Revolving Breech Fire Arms;* Henry S. North, Middletown, and Chauncey D. Skinner, Haddam, Connecticut, June 1.

Claim.—"What we claim as our invention is, the construction of the sliding crotch, substantially as described, to enable it to perform the double purpose of revolving the breech and wedging it up against the barrel; and the combination of the sliding crotch and guard lever, constructed and arranged as specified, by which the breech is rotated, wedged forward, and the gun cocked by one motion back and forward of the trigger guard, or its equivalent, substantially as above described."

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7. For an *Improvement in Smut Machines;* G. S. Peck, East Smithfield, Pennsylvania, June 1.

Claim.—"What I claim as my invention is, the arrangement in which the grain is fed in at or near the bottom of the cylinder, through which it is elevated, by means of spirally inclined beaters, and discharged through the passage or spout, in combination with the ascending blast from the fan or blower, the same being arranged and operated essentially as above set forth and described."

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8. For *Improvements in Power Looms;* Rensselaer Reynolds, Valatia Village, New York, June 1.

Claim.—"What I claim as my invention is, 1st, Connecting the rocker of each picker staff, made and operated substantially as specified, with the bed on which it rocks, by means of an interposed strap of leather, or other flexible substance, attached at the inner end to the bed, and at the outer end to the rocker, substantially as and for the purpose specified.

"2d, Forcing the shuttle binders inwards against the shuttle while boxing, by a gradually increasing force, by means of arms on a rocker, provided with a spring, which is acted upon by a pin on the connecting rod of the lay, substantially as described.

"3d, Securing the raw hide pickers to the inner face of the staffs, by means of a leather strap, or the equivalent thereof, embracing and binding the two together, substantially as described, to insure the firm union to resist the rapid blows, and to prevent pieces of raw hide from breaking and flying, as set forth."

9. For an *Improvement in Cast Iron Car Wheels;* Daniel R. Rall, Rochester, New York, June 1.

Claim.—"I do not claim the concave plates or sides of the wheel; nor do I intend to limit myself to the precise form of such plates connecting the hub with the rim or tread of the wheel. But I claim the partitions or braces connecting the rim or tread with the two plates or sides of the wheel, the said partitions or braces extending from the inside of the rim or tread radially, or nearly so, part of the distance towards, but not connecting with the hub, as herein fully set forth."

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10. For an *Improvement in Fire Escape Ladders;* John C. fr. Salomon, Georgetown, District of Columbia, June 1.

Claim.—"What I claim as new is, forming or constructing a ladder with each successive step, from the end or ends, longer than the one preceding it, and connecting said steps with each other by links made fast at one end to each step, and the other end sliding through eyes in the step above or below, so that the steps can all fold closely together, in the manner substantially as described."

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11. For *Improvements in Looms for Weaving Piled Fabrics without the Figuring Wires;* Robert W. Sievier, Cavendish Square, England, June 1, 1852; patented in England, September 5, 1844.

"My invention consists, 1st, in a peculiar mode of producing and raising the terry or loops of such fabrics as Brussels carpeting, coach lace, velvets, or other similar fabrics, and which are woven by me, without the aid of intervening wires or tags, as commonly employed, to form such terry or loops, or raised surfaces; and, 2d, in certain improvements in looms, in order to render the same more capable of effecting that object."

Claim.—"Having now described the particular feature of my improvements in looms for weaving, and the mode or method of producing plain or figured goods or fabrics, I desire it to be understood that I claim as my invention, 1st, The novel mode or method of producing plain or figured goods or fabrics, having terry or looped surfaces of the kinds above described, by partially beating up certain picks of the shoot or weft threads, and afterwards further beating up or driving home those picks or shoots, in order to cause certain portions of the terry warp to pucker up in loops; but I do not confine myself to any particular number of picks or shoots of weft, but have described a method by which my improvements in producing plain or figured goods or fabrics, having a terry or looped figure, may be accomplished, as the number of picks or shoots of weft may be varied, to produce a different appearance in the face of the fabrics woven under my patent, according to the desire of the weaver.

"2d, I claim varying the forward stroke of the batten, to produce the open or close beating up of the weft, substantially as described, in combination with the apparatus for holding the surface threads or yarns, and carrying them forward in the manner described, or any other substantially similar, for the purpose of aiding in forming, in the loom, the loops of terry fabrics."

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12. For an *Improvement in Vertical Trip Hammers;* Peter Stebbins and John Holmes, Schenectady, New York, June 1.

Claim.—"We are aware that vertical trip hammers, elevated by friction rollers, are not new; neither are cams for regulating the elevation to which such hammers shall be lifted; and therefore we do not claim them: but what we do claim as our invention is, 1st, The recessed rollers in combination with the plain rollers and springs, or their equivalents, for controlling the operation of the lifting rollers; the projections on the said recessed rollers causing the shaft, lifting roller, and plain rollers to recede or move from the rollers on the shaft, and thereby allow of the hammer to fall; the whole being constructed, and arranged, and operating substantially as herein described.

"2d, The manner herein described of regulating the blow of the hammer, by making the recesses in the periphery of the rollers of unequal lengths, and making the said rollers movable on their shaft, so that either projection can be brought opposite to and made to act in combination with the plain rollers in the manner herein set forth."

13. For an *Improvement in Machines for Turning and Polishing;* Benjamin J. Tayman, Philadelphia, Pennsylvania, June 1.

Claim.—"What I claim as new is, the arrangement of a polishing belt for polishing circular surfaces in such manner that a bight of it shall pass round the article to be polished, and move concentrically, or nearly so, to the surface thereof, so as to finish the same rapidly, and without the danger of making flat places in its periphery, which is always so imminent when a round article is polished, by bringing it in contact with a polishing surface moving in a straight line.

"I likewise claim the combination of the rotating tubular cutter, for turning the rod with the polishing belts, which, while polishing one end of the rod, grasp it firmly and hold it from turning, while its other end is under the action of the cutters, as herein set forth."

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14. For *Improvements in Engraving Surfaces;* Isaac Taylor, Stanford Rivers, England, June 1, 1852; patented in England, February 21st, 1849.

Claim.—"What I claim as my invention is, 1st, The connecting of rhomboidal frames or pentagraphs in series, so as that the one which first receives a movement from the hand or other moving power, conveys its movement to a second, and this again, if required, to a third, and so on as far as the nature of the work to be done may need a high diminution to be carried."

"2d, I claim as my invention the placing of rhomboidal frames or pentagraphs in pairs, so connecting each pair by a rod or bar, at the working joint of each, as that a true geometric point of movement is presented upon every point or spot of such rod or bar, whether the said rod or bar be made to communicate motion to the cutting or other tools which act upon a fixed surface, or whether it be made to communicate motion to the surface itself, either plane or cylindrical, while the tools are fixed. These tools, which may be of any number convenient to apply, or required by the work, may be diamond or steel points, gravers, punches, drills, pencils, pens, or tubes for conveying colors.

"3d, I claim as my invention, the conveying the movement of the above mentioned rod or bar connecting two pentagraphs, to a cylinder or roller, in such manner as that when points or tools of any required kind are applied to the surface of the same, and in whatsoever direction, whether vertically or on the sides horizontally or beneath, each point or tool brought into contact with the cylinder, produces thereupon the same figure or mark of whatever kind which it would produce, if operating upon a plane surface.

"4th, I claim as my invention, the construction of a frame, called in my specification a ruling board, which, by transferring the weight of a loaded cylinder alternately from the sides or bearers of an external and internal frame, allows each frame in its turn to move backward or forward a distance regulated by screws or other similar means. In this manner, and by the application of a carriage or traversing point to one of these frames, lines may be ruled or engraved, with perfect accuracy as to their distance one from the other."

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15. For an *Improvement in Processes of Manufacturing Gutta Percha;* John Rider, City of New York, June 1.

Claim.—"What I claim as new is, the preparing of gutta percha for vulcanizing, by a preliminary separate heating of it to such a degree, as to expel its volatile ingredients herein specified, which I find can generally be effected at the high temperatures from 285 to 430 degrees Fahrenheit, substantially as herein set forth.

"I also claim the process herein described, of vulcanizing gutta percha, by first heating it to a sufficiently high temperature to expel from it the volatile ingredients herein specified, which it is believed can be accomplished between 285 and 430 degrees Fahrenheit, and then incorporating with it, substantially as herein specified, a hyposulphite, either alone or in combination with metallic sulphurets, or whiting, or magnesia, or with all of them together, and then subjecting the mixture to a temperature of from 285 to 320 degrees Fahrenheit; all the steps of the said process being performed substantially in the manner herein set forth. At the same time, desiring it to be understood that I disclaim the vulcanizing of gutta percha in all cases, save when it has been prepared for the vulcanizing operation by the aforesaid preliminary heating."

LAW REPORTS OF PATENT CASES.

Reported for the Journal of the Franklin Institute.

Woodworth Planing Machine Cases.

Sloat vs. *Patton*. *Sloat* vs. *Winslow*. *Wilson* vs. *Snowden*. *Wilson* vs. *Ashton*.—*Motions for Special Injunctions.*

Before Hon. John K. Kane, holding Circuit Court for Eastern District of Pennsylvania.

These were four cases in equity heard during the April Sessions of the Court, on bills and affidavits upon application for special injunctions. The complainants in the several bills were the assignees of the exclusive right to use the planing machine of William Woodworth, for the extended term of the patent, within the County of Philadelphia.

The infringement complained of in the first of the above suits, Sloat *vs.* Patton, was alleged to consist in the use of a planing wheel of a nearly disk form, slightly inclined in its plane of revolution to the plane of the board to be operated upon. The planing knives were so placed in this wheel, that when it revolved the edge of those knives generated the surface of an obtuse cone. It was stated by the complainant, that the board to be planed was controlled by pressure upon its surface by means equivalent to those described in Woodworth's Patent; that this defendant thus employed a combination of pressure rollers with rotating knives, substantially the same as described in the Woodworth Patent. It was further alleged, that the machinery employed by this defendant to tongue and groove the boards, was an infraction of another claim of the same patent. This machinery consisted of elliptical saws or plates, placed on vertical axles in an inclined position to such axles, so that the teeth of these elliptical saws or plates would describe the convex surface of a cylinder when the plates were revolved. It was further said, that the means of controlling the board, while under the action of the tonguing and grooving wheels, were analogous to those patented.

The Court declined hearing argument from the defendant on the validity of the Woodworth Patent at this stage, referring to previous trials and investigations in that Court as having determined that question. The defendant denied that the machines used by him infringed upon any claim of the complainant's patent. He asserted and read affidavits to establish the fact, that the planing wheel employed by him was a simple disk, and described in its revolution a plane parallel with the face of the board, and not the surface of a cone. He said that in his machine pressure to control the board was neither used nor required to be used. His tonguing and grooving tools, he insisted, were entirely unlike in form and principle of operation to the cutters of Woodworth. Many affidavits of a contradictory character were read on both sides, and Professor Byrne was examined orally on behalf of the defendant, and Harvey Waters on behalf of the complainants.

The machines used by Winslow and by Ashton, the defendants in the second and fourth of the above suits, it was alleged by the complainants, bore a still closer resemblance to those patented by Woodworth. It was

contended that the tonguing and grooving apparatus in these machines was identical with that of Woodworth, and that the planing wheels employed by these defendants were so placed as to describe a more clearly perceptible cone than in Patton's machine. On behalf of these defendants, it was admitted that the tonguing and grooving tools were similar to those of Woodworth; but it was insisted that the planing wheel did not describe a conical surface, and that pressure was neither required nor used while the board was being planed.

Two bills had been filed against Snowden, the defendant in the third suit,—one was filed by J. P. Wilson, as assignee of the Woodworth patent, and the other by J. P. Wilson, as assignee of the Barnum planing machine patent. It was complained that Snowden infringed on the Barnum patent, by using the precise machine described and patented by Barnum for planing; and that he infringed on the Woodworth patent by using the same tools and combination in tonguing and grooving as were described therein. The latter infringement was not denied by the defendant during the argument, but it was contended that the defendant had acquired a right to use the Barnum machine, by virtue of a license from Barnum, the former owner of the patent, and subsequently it was contended that he had acquired this right by the purchase of a machine from Barnum. The complainant denied that any valid title was acquired by Snowden in either manner as alleged.

During the course of the evidence, affidavits stating that the complainants had been unable to obtain access to examine the respective defendants' machines were read, and application was made to the Court for an order of inspection. Whereupon the following order was made:—

"That the respective defendants do permit an inspection and thorough examination by Harvey Waters, on behalf of the complainants in the above cases, of the planing, tonguing, and grooving machines in controversy, in each case respectively, and that the said expert be permitted to bring any specimens of the work done by the said machines; and that the said machines shall be worked by the servants of the respective defendants as the said Harvey Waters may request."

Mr. Waters afterwards was examined in Court as an expert, and exhibited specimens of the boards planed at the several machines. In the course of the trial, a very ingenious working model of a planing machine was introduced into Court by the last named expert. Its essential feature was a Woodworth planing cylinder, so constructed and arranged that while the operation of planing was going on, this cylinder could be altered to a cone or to a disk, and vice versa.

The four cases were argued at the same time. Mr. Campbell, Mr. Keller, and Mr. Harding appeared for all the complainants, and Mr. Cuyler appeared for all the defendants. Mr. Hubbell also appeared for Patton, and Mr. Taylor for Winslow.

The Court having taken time to consider, delivered the following opinion on the 28th of May last, granting injunctions in all the cases as prayed for.

Opinion.

The effort to smooth boards and reduce them to a uniform thickness by the rotary action of cutter knives set in the face of a disk, and made

to revolve in the plane of the intended surface, is of ancient date. But from the time of Bramah, half a century ago, until now, it has never been successful.

If it were practicable to construct a machine, mathematically accurate in all its parts, and of inflexible material, so as to prevent all possible vibration; and if, besides, the wood to be operated on could be first deprived of all its elasticity, then each cutter as it passed on its way, removing a certain portion of the board, would leave the surface absolutely finished behind it—and the other cutters and the same cutter returning in its revolution, all following in absolutely the same plane with the first, would pass over the finished surface, neither abraiding it nor compressing it, yet in contact with it.

But these conditions involve mechanical impossibilities. The strongest engine that ever came from the shops, vibrates sensibly when it encounters an intermitting resistance, and there is no such thing as a non-elastic. The practical consequence is, that the cutters after finishing their work, still continuing to revolve over the smoothed surface, will sometimes be impelled for the instant below the plane of their normal action; and on the other hand, the board partially compressed when under the action of each cutter in succession, but rising again immediately afterwards by its own elastic force, will present a new surface to be acted on by the next cutter—that surface varying in height according to the varying density and consequent elasticity of the board. This is illustrated by the *back-lash*, an irregular trace made on the finished surface by the cutters that continue to pass over it.

Woodworth was the first to propose a remedy for this, by placing his cutters on the periphery of a rotating cylinder, while he presented the face of the board in the tangent plane of their revolution. He thus prevented the cutters, while the board was moving, from tracing it a second time, and gave the *dip and lift cut* which has been so often recognised as the characteristic of his patented machine.

It is obvious that to make this cut, it is not necessary to place the cutters on a true cylinder. A cone, or even a dished wheel, scarcely deviating in appearance from a true disk, will produce the same effect, provided the board approaches and leaves the cutters in the tangent plane of their revolution. I had no difficulty, therefore, when the cases of Plympton and Mercer and others were before me, some years ago, in holding that a cone or dished wheel so arranged, was simply a mechanical equivalent for the cylinder of Woodworth; and the rulings then made, have, on more than one occasion since, received the sanction of both the judges of this Court.

Strange to say, in three of the cases now before me, the principal dispute has been as to the fact, whether the machine used by the defendants is or is not a *disk*, or, as it has been spoken of in the argument, a Bramah wheel. Numerous witnesses, some of them highly respectable, have testified that it is nothing else—and that its cutters move of course in the same plane, and parallel with the lower face of the board—in other words, that the cutting disk coincides in its revolutions with the finished surface. But it is as certain as any truth in the philosophy of mechanics, that in this they are mistaken—for the machine in its ordinary working

leaves no back-lash, and the boards that were passed through it by one of the gentlemen who inspected it under the Court's order, show unequivocal marks of the dip and lift cut.

Neither witness nor counsel has explained how a disk which all describe to be like Bramah's wheel, and worked as his was, can produce results so different from his; nor how it happens that the results produced by it are so precisely those which would be produced by cutters revolving on a flattened cone. On the contrary, all admit that the machine does vibrate, and that the boards which it commonly works on are damp, if not wet, and of course easily compressed under the cutters. It is to exact more than a reasoning faith in human testimony, to assure us that such a machine acting on such a material, will in the hands of the defendants renounce the mechanical law which it has been exemplifying every where else for the last fifty years.

It is true, that upon *tramming* the disk with the bed plate, in order to test their parallelism, the defendant's witnesses observed no deviation from the disk form. But though this were so, yet in just such a disk the cutters might be arranged in such a manner as to describe a cone when revolving; and Mr. Patton's cutters were not, and probably could not be trammed. Besides which, the axis of the disk was so adjusted at its upper extremity, as to give it at pleasure the oblique action which is adapted to the revolving cone, and yet to restore it again in a few minutes, with the disk parallel to the bed plates.

When we consider that the machine while at rest can have its character thus easily modified, so as to give proof for the time of the parallelism of its parts, if such proof be desirable, and that while in motion, it defies all scrutiny, revolving, it may be, some 3000 times in a minute, and its three cutters therefore following each other with an interval between them of but the 150th part of a second; and that an obliquity in the disk, not exceeding the $\frac{1}{16}$-th of an inch on its cutting diameter, would be sufficient to change its effective action; we can apprehend without difficulty that the defendant's witness may have fallen, very honestly, into error. But it is enough for us to know, that according to the laws of matter and motion, which are the condensed expression of all mechanical experience, the machine, as they describe it, cannot produce the effects, which we see that the machine produces in fact. The foot print on the sand indicates with less certainty the form and pressure of the foot that made it, than a curved cut on the face of a flat board proves a corresponding curvature in the path of the cutting tool.

It is in vain to refer us for an explanation to the abnormal influences of vibratory or semi-elastic forces, without showing us what those influences are, and how they resolve—they resolve for the time a disk into a cone, or enable the machinist to trace a regulated curvilinear surface by the rectilinear movement of a plane. This is only to reassert the paradox in more general language, to prove the controverted fact by reference to an unknown theory.

I must hold, therefore, that the planing machine of Messrs. Patton, Ashton & Winslow, and Ashton & Beer, are essentially the same with the planing apparatus of the Woodworth patent.

The machine employed by Mr. Patton, and, as it is said, invented by

him, for cutting the tongue and groove, is spoken of as an elliptical saw. It consists of a revolving saw plate of lozenge shape, set at such an oblique angle as to make all the teeth on its periphery equidistant from its action of motion. In revolving, it describes, of course, a cylinder, and its action is that of a rasp. It does not divide the board as a saw does; but performs the office of Woodworth's duck-bill cutter, somewhat less perfectly, and apparently at greater cost. The only points of difference are that what would be the one cutter of Woodworth is, in Mr. Patton's machine, effectively divided into several, so as to form a series of cutting disks or saws, the teeth of which abrade in succession the portions of the board to be removed, leaving the edges rough in consequence, instead of giving them the comparatively smooth surface of the Woodworth machine; and that while a broken cutter can be removed from the Woodworth disk, and a new one substituted, a tooth broken from Mr. Patton's saw destroys it. Whatever, therefore, may be the supposed interest or novelty of the elliptical saw, it must in its adaptation to this particular use, be regarded as embodying the principle, and constituting, but for its inferiority, the mechanical equivalent of Woodworth's cutting wheel.

The tonguing and grooving apparatus of the Ashton and Winslow, and Ashton and Beer machines, are confessedly those of Woodworth's patent.

The same is true of Snowden's; and his planing machine is an equally direct piracy of the Barnum patent, now held by the complainant.

I have not, in this opinion, discussed the question of the validity or the extent of Woodworth's patent. These have been so often before almost all the Courts of the United States, as to make them inappropriate topics for interlocutory argument. There must be at some time or other an end of controversy as to the character of a patentee's property in his invention; and now that twenty-three years have gone by since the Woodworth patent was issued and passed into litigation, I am disposed to recognise its parting claim to repose; *solve senescentem*. I therefore limited the discussion at its outset to the single question of infringement.

I have one more remark to make, it is prompted by a review of the devices employed by these defendants and those who have gone before them in similar controversies. I cannot but think that the time has come, when, in this District at least, the attempt to mask an infringement of this particular patent should be almost regarded as a waste of ingenuity. It is a truth of large acceptation, both in policy and morals, that it is better in the long run to strive patiently for a legal property of one's own, than to persist in trespassing on the property of others. The invention which is set forth in letters patent *belongs* to the inventor—as rightfully as the house he has built or the coat he wears. It cannot detract from the dignity of his title, that the subject of it is of his own creation, his thought conceived and developed and matured in the recesses of his mind, that it has cost no man else any thing, and asks nothing in return for the contribution it makes to the general wealth and happiness, but that security of enjoyment, during a limited period, which the laws engage for all other property without limitation of time, and without stipulating a price. It would be a reproach to the judicial system, if an ownership of this sort could be violated profitably or with impunity.

The complainant's counsel will prepare the draft of decretal orders in he several cases in accordance with this opinion.

MECHANICS, PHYSICS, AND CHEMISTRY.

For the Journal of the Franklin Institute.

Inconsistency and Error of the Conclusion arrived at by a Committee of the Academy of Sciences of France, agreeably to which, Tornados are caused by Heat; while, according to Peltier's Report to the same body, certain Insurers had been obliged to pay for a Tornado as an Electrical Storm. With Abstracts from Peltier's Report. By Dr. Hare.

In the 2d series of queries proposed to Mr. Espy, published in the May number of this *Journal*, allusion is made to the report signed by Arago, Pouillet, and Babinet, three distinguished members of the Academy of Sciences of France, sanctioning the idea that tornados are due to the heat of condensing vapor, when agreeably to a report made under the auspices of Arago, the President of that Academy, less than two years before, certain insurers had been obliged to pay for a tornado as an electrical storm.

It is remarkable that Arago, one of the most distinguished electricians in Europe, when requested to decide this question, did not conceive himself warranted in saying whether or not a tornado was an electrical storm. Had the damage been done by lightning, there would have been no doubt as to the nature of the cause; but as it was done by the meteor above mentioned, (called trombe in French,) Arago felt it necessary to send Peltier to examine the phenomena, in order to find out whether or not they were due to electricity. It had often been observed that electrical phenomena were attendant on such storms, and by some observers they had been ascribed to electricity; yet so vague and unsatisfactory had been the evidence or arguments in favor of this view of the question, that they seem to have made no impression on the minds of the sagacious, learned, and ingenious members of the "Academie des Sciences."*

Such, at all events, is the only inference which can be reasonably drawn, judging from the opinions expressed by those among them, who were selected as eminently competent to decide.

It is manifest that Arago had formed no opinion, or he would not have sent Peltier to investigate the phenomena, in order to determine the question. As this philosopher, Pouillet, and Babinet, were chosen as a committee to decide on Espy's theory of tornados, it is to be presumed that they were considered as among those members who were pre-eminently qualified to judge, respecting meteorological theories. Let us then see

*Among those who alleged them to be due to electricity, Beccaria is, perhaps, the most distinguished; but how little he understood the true nature of the meteor, is manifest from his crediting the allegation that they could be dissipated by the presentation of a sword from the deck of a vessel. Evidently no vessel could come within the electrified column without being dismantled, if not wrecked; and if situated outside of the electrified column, how could the electricity reach the sword? But should it be induced to leave its wonted vertical path, in order to pass off by this weapon, how could the person presenting the sword survive an influence capable of rending the wood of trees into laths, as alleged by Peltier!

whether any of the other academicians were, more than Arago, impressed with the idea that electricity was the main cause of tornados.

I subjoin the opinions of Pouillet first.

"*How can this power, sometimes so prodigious, be created in the midst of the sky?* This is a question to which, it must be admitted, science as yet cannot give a precise answer. Of all the vague and hazardous conjectures which have been made respecting the origin of this meteor, probably the least unreasonable is, *that it is a whirlwind of excessive intensity.* But the discussion of this point seems premature. It is necessary to multiply observations, and to compare with more precision all the attendant circumstances of the phenomena." *Pouillet Elemens de Physique Experimental et de Meteorologie.*

To allege a tornado to be a whirlwind, without showing how a whirlwind may be produced or sustained in the case in point, is only substituting one mystery for another. Whirling or gyration is an *effect*, not a *self*-moving power, as some meteorologists seem to suppose.

All the elucidation given by Depretz, another luminary belonging to the same illustrious Academy, is contained in the following language, which is a literal translation from his Traite Elementaire de Physique, page 329:

"*The tornado* ("*trombe*") *is seen upon the sea and upon the land. Sometimes it seems to come out from the bosom of the sea, ascending to the clouds; sometimes it descends from the clouds down to the earth.*"

"*It is a conical column of water, which revolves upon its axis, with great rapidity. The base is sometimes more than two hundred metres in diameter.*"

"*An idea may be had of tornados from the little whirlwinds of dust which suddenly form themselves in summer, revolving with great rapidity.*" Risum teneatis amici!*

That Babinet entertained no feasible idea of the part performed by electricity in the generation of the tornado, is evident; since, after a long discussion, in which no allusion is made to electricity as essential, he terminates with a conclusion favorable to the Espyan hypothesis, and in which electricity is referred to only as a subordinate participant playing a part, respecting which he shows himself incapable of throwing any light. I subjoin his "*conclusion*," as he designates his ultimate brief exposition of those inferences which his study of the question led him to make.

I use the singular pronoun, his, because Arago assured me he had

* "Comment cette puissance quelque fois si prodigieuse peut-elle prendre naissance au milieu des airs? C'est une question, il faut le dire, à laquelle la science ne peut faire aucune réponse précise. De toutes les conjectures vagues et hazardées que l'on peut faire sur l'origine de ce météore la moins invraisemblable est peut être celle qui le regarde comme un tourbillon d'une excessive intensité. Mais une discussion sur ce point nous semblait prematurée, il faut multiplier les observations et constater avec plus de precision toutes les circonstances de ces phénoménes." Elémens de Physique et de Météorologie, Tom. 2, page 727.

Tous les détails que Despretz donne sur les trombes se trouvent dans ces paragraphes que j'emprunte à son traité de Physique.

"*Trombe.* La trombe se montre en mer et sur la terre; tantôt elle semble sortir du sein de la mer et s'élève jusqu'aux nuages; tantô elle descend des nuages jusqu'à tèrre.

Cest une colonne d'eau conique qui tourne sur elle même avec une grande vitesse; elle a quelque fois jusqu'à plus de deux cents mètres de base. Elle est très-commune entre les Tropiques. Les navigateurs passent rarement près des côtes de Guinée sans en apercevoir plusieurs.

Les trombes produisent des effets terribles, elles déracinent les arbres renversent les faibles habitations soulèvent les voitures etc.

Ou peut se faire une idée des trombes par des tourbillons de poussière qui se forment tout-a-coup en été sur les routes et qui tournent sur eux mêmes avec une grande rapidité Traité Elem. de Physique, parag. No. 656, pag. 828.

nothing to do with the report, and Pouillet let it pass, because Arago could not attend, and he could not agree with Babinet; while Espy was very urgent to have the report before leaving Paris.

Babinet's "Conclusion."

"In conclusion, Mr. Espy's communication contains a great number of well observed and well described facts. His theory, in the present state of science, alone accounts for the phenomena, and, when completed, as Mr. Espy intends, by the study of the action of electricity when it intervenes, will leave nothing to be desired. In a word, for physical geography, agriculture, navigation, and meteorology, it gives us new explanations, indications useful for ulterior researches, and redresses many accredited errors.

"The committee expresses then the wish, that Mr. Espy should be placed by the government of the United States in a position to continue his important investigations, and to complete his theory, already so remarkable, by means of all the observations and all experiments which the deductions even of his theory may suggest to him, in a vast country, where enlightened men are not wanting to science, and which is besides, as it were, the home of these fearful meteors.

"The work of Mr. Espy causes us to feel the necessity of undertaking a retrospective examination of the numerous documents already collected in Europe, to arrange them, and draw from them deductions which they can furnish, and more especially at the present period, when the diluvial rains, which have ravaged the south-east of France, have directed attention to all the possible causes of similar phenomena. Consequently, the committee proposes to the Academy to give its approbation to the labors of Mr. Espy, and to solicit him to continue his researches, and especially to try to ascertain the influence which electricity exerts in these great phenomena, of which a complete theory will be one of the most precious acquisitions of modern science."

Mr. Espy is to study the action of electricity "*when it intervenes.*" Of course, it was only a visiter, according to Babinet's opinions.

Such was the state of knowledge respecting tornados in 1836, when I handed to Arago and other members, copies of my pamphlet, in which I attributed those awful meteors to a convective discharge of electricity in these words: "*After maturely considering all the facts, I am led to suggest that a tornado is the effect of an electrified current of air superseding the more usual means of discharge between the earth and clouds in those sparks or flashes which we call lightning.* While the air is thus carried up by the concurrent influence of electrical attraction and the reaction of its own previously constrained elasticity, other bodies are lifted both by electrical attraction and the blast of air to which it gives rise. Hence houses within the sphere of excitement are burst by the expansion of the air which they contain, their walls being thrown outwards and their roofs carried away, while by the afflux of the atmosphere requisite to the restoration of its equilibrium, trees, houses, and other bodies are thrown inwards towards the vertical current from before as well as from either side."

This rationale of the tornado had been in the hands of the academicians and the library of the Academy for about three years, when, agreeably to an article published at Paris, on July 17th, 1839, in the *Journal des Debats*, a tremendous tornado occurred about the last of the preceding month, at Chatenay, in the vicinity of that metropolis. The losers applied for indemnity to certain insurers, who objected to pay on the plea that the policies were against thunder storms, not againt tornados. This led to an application to the celebrated Arago, who referred the case to another savant, Peltier, as above stated.

From the following narrative, translated from his report, it will be seen

that Peltier adopted my opinion, that a tornado is the effect of an electrical discharge.

"Early in the morning a thunder cloud arose to the south of Chatenay, and moved at about ten o'clock over the valley between the hills of Chatenay and those of Ecouen. The cloud having extended itself over the valley, appeared stationary, and about to pass away to the west. Some thunder was heard, but nothing remarkable was noticed, when about midday, a second thunder storm, coming also from the south, and moving with rapidity, advanced towards the same plain of Chatenay. Having arrived at the extremity of the plain above Fontenay, opposite to the first mentioned thunder cloud, which occupied a higher part of the atmosphere, it stopped at a little distance.

* * * * *

"Up to this time there had been thunder continually rumbling within the second thunder cloud, when suddenly an under portion of this cloud descending and entering into communication with the earth, the thunder ceased. A prodigious attractive power was exerted forthwith, all the dust and other light bodies which covered the surface of the earth mounted towards the apex of the cone formed by the cloud. A rumbling thunder was continually heard. Small clouds wheeled about the inverted cone, rising and descending with rapidity. An intelligent spectator, M. Dutour, who was admirably placed for observation, saw the column formed by the tornado terminated at its lower extremity by a cap of fire; while this was not seen by a shepherd, Oliver, who was on the very spot, but enveloped in a cloud of dust.

"To the south-east of the tornado, on the side exposed to it, the trees were shattered, while those on the other side of it, preserved their sap and verdure. The portion attacked appeared to have experienced a radical change, while the rest were not affected.

* * * * *

"Finally, it advanced to the park of the castle of Chatenay, overthrowing every thing in its path. On entering this park, which is at the summit of a hill, it desolated one of the most agreeable residences in the neighborhood of Paris. All the finest trees were uprooted, the youngest only, which were without the tornado, having escaped. The walls were thrown down, the roofs and chimneys of the castle and farm house carried away, and branches, tiles, and other movable bodies, were thrown to a distance of more than five hundred yards. Descending the hill towards the north, the tornado stopped over a pond, killed the fish, overthrew the trees, withering their leaves, and then proceeded slowly along an avenue of willows, the roots of which entered the water, and being during this part of its progress much diminished in size and force, it proceeded slowly over a plain, and finally, at the distance of more than a thousand yards from Chatenay, divided into two parts, one of which disappeared in the clouds, the other in the ground."

"In this hasty account I have, with the intention of returning to this portion of the subject, omitted to speak particularly of its effect upon trees. All those which came within the influence of the tornado, presented the same aspect; their sap was vaporized, and their ligneous fibres had become as dry as if kept for forty-eight hours in a furnace heated to ninety degrees above the boiling point. Evidently there was a great mass of vapor instantaneously formed, which could only make its escape by bursting the tree in every direction; and as wood has less cohesion in a longitudinal than in a transverse direction, these trees were all, throughout one portion of their trunk, cloven into laths. Many trees attest, by their condition, that they served as conductors to continual discharges of electricity, and that the high temperature produced by this passage of the electric fluid, instantly vaporized all the moisture which they contained, and that this instantaneous vaporization burst all the trees open in the direction of their length, until the wood, dried up and split, had become unable to resist the force of the wind which accompanied the tornado. In contemplating the rise and progress of this phenomenon, we see the conversion of an ordinary thunder gust into a tornado; we behold two masses of clouds opposed to each other, of which the upper one, in consequence of the repulsion of the similar electricities with which both are charged, repelling the lower towards the ground, the clouds of the latter descending and communicating with the earth by clouds of dust and by the trees. This communication once formed, the thunder immediately ceases, and the discharges of electricity take place by means of the clouds, which have thus descended, and the trees. These trees, traversed by the electricity, have their temperature, in consequence, raised to such a point that their sap is vaporized, and their fibres sundered by its effort to escape. Flashes, and fiery balls, and sparks accompanying the tornado, a smell of sulphur remains for several days in the houses, in which the curtains are found discolored. Every thing proves that the tornado is nothing else than a conductor formed of the clouds, which serves

as a passage for a continual discharge of electricity from those above, and that the difference between an ordinary thunder storm and one accompanied by a tornado, consists in the presence of a conductor of clouds, which seem to maintain the combat between the upper portion of the tornado and the ground beneath."

Less than two years after the allegations and inferences comprised in the preceding abstracts were reported to the Academy, and after the insurers had been obliged, as *Peltier informed me*, to pay for it as an electrical storm, Babinet sanctioned the idea that the main cause of tornados is the heat imparted to an ascending column of air by condensing vapor, electricity occasionally intervening, but not being in the least essential to the generation or endurance of the meteor.

There is another narrative published in the *Comptes Rendus*, or Journal of the Proceedings of the Academy, which confirms that of Peltier in every essential particular. Both of these narratives agree with that which I had given respecting the tornado of New Brunswick, excepting that the chemical effects upon the trees appear to have been more violent at Chatenay.

Although Peltier made his report (of which abstracts have been given) three years after I personally handed my pamphlet to Arago and other members, leaving one in the library of the Academy, he alluded to my memoir only in order to show that he owed nothing to it. In the point of the greatest and most evident importance I had manifestly anticipated him. I allude to the inference, that during a tornado an electrical discharge takes place by means of the column or trunk, superseding the lightning by which, during ordinary thunder storms, discharge is effected. There is, *so far*, a perfect identity between his inferences and mine. These, with the facts established by the survey at New Brunswick, and by his own statements, shew that there can be no rational explanation of a tornado, but that of its being the result of a convective discharge. I am not in the least disposed to contest any honor which he may have acquired from so much of his explanations as are inconsistent with that given by me.

That the idea of Peltier that the cloud acts as a conductor is untenable, must be evident, since the light matter of which a cloud is constituted could not be stationary between the earth and sky in opposition to that upward aerial current of which the violence is admitted by him to be sufficient to elevate not only water, but other bodies specifically much heavier than this liquid.

Moreover, I have ascertained that dense fog produced within a glass vessel, does not act as a conductor so as to discharge an electrified knob of iron. When subjected to the exciting power of an electrical machine, the knob gave sparks as well when the fog was present, as when it was away. The knob was made red hot, to prevent the interference of condensing moisture.

But independently of this experimental evidence, were moisture in the state usually designated as fog or cloud a conductor, how could it issue from an uninsulated high pressure boiler highly charged with electricity? As soon as, by the escape from confinement, the pressure is relaxed, one portion of the steam is resolved into low pressure or rare steam, while another portion precipitating, assumes the state of the aqueous matter in a cloud.

The upward current of air, and the carrying up of movable bodies, which has been fully established to be characteristic of tornados, and of which Peltier himself confirms the existence, is irreconcilable with conduction, but is just what a carrying discharge would involve as a matter of course.

Subsequently to the publication of my memoir on the cause of tornados, in the *American Philosophical Transactions*, and *Silliman's Journal*, for the year 1837, Faraday distinguished that species of electrical discharge which takes place by a current of air, or by the movement of bodies situated between the electrified surfaces, and consequent alternate contact therewith, as the "*convective* discharge;" while the discharge by means of sparks or lightning were designated by him as *diruptive*.

The employment of these terms renders the demonstration of my rationale more easy to state. These modes of discharge have been witnessed by every person who has ever been present when the most common routine of electrical experiments has been exhibited, in which not only the spark is shown, but the dancing of pith-balls, or of puppets, the ringing of bells, the rotation of wheels, or the blasts produced by electrified points, causing such wheels to rotate.

It is notorious that either of these modes of discharge may be made to take place, by varying the distance, or the form or character of the masses employed.

Thus, in the experiment in which pith-balls are made to resemble hail, by dancing between oppositely electrified disks, an approximation of one of the disks towards the other induces a spark or diruptive discharge, and thus causes dancing to cease. In Cuthbertson's balance electrometer the movable ball approaches that which is stationary, in obedience to the convective process; but as soon as the distance between the balls is reduced within the striking distance, a diruptive discharge ensues, indicated as usual by a spark.

It follows that by a slight variation as to distance, the same degree of electrical excitement may be productive either of a convective, or of a diruptive discharge. Excepting a prodigious disparity in magnitude, the diruptive spark discharge is universally recognised as perfectly similar to lightning. Both the one and the other process are admitted to be due to discharges of electrical accumulations, differing only as to magnitude. Since, agreeably to this exposition, susceptibility of commutation exists, as respects diruptive discharge in its minuter forms, and convective discharge upon the same scale, does it not follow that the former, as produced by the gigantic processes of nature, should be commutable with a convective process of corresponding immensity? But if the spark be exemplified by lightning, how is the convective discharge to be exemplified? Where is there any gigantic meteorological process which can supply the deficiency, excepting that of the tornado or hurricane, which last may be viewed as a tornado on a scale of pre-eminent grandeur?*

* Experience shows that the denser portion of the atmosphere, which lies between the storm clouds and the earth, is competent to act as an electric; since otherwise there would be no thunder gusts, nor any atmospheric discharges as displayed in the form of lightning. That air, rarefied to a certain degree, becomes capable of acting as a coating does in the instance of the Leyden jar, is proved by the fact that the inner surface of a glass globe, within which the air is rarefied by exhaustion, may be charged like a Leyden jar, if to the

If from a point electrified by a machine, a blast of air may proceed as strong as from a blow-pipe supplied by a bellows, may not an enormous blast be emitted from every terrestrial prominence, electrified by the powerful apparatus of nature, as much greater than that of a blow-pipe, as a spark of lightning of a mile in length, exceeds that yielded by an excited conductor or charged jar? So long as there is an ascent of air consequent to electrical convection, there must be a confluence of the same fluid from two or more opposite quarters, to supply the deficit thus created; and the air as it follows the electrified column being successively similarly electrified, that enduring trunk or column is formed and sustained which characterizes tornados or water-spouts.

Within this traveling trunk, which, in its form, contortions, and deleterious power, resembles that of an enormous elephant, as mischievous as gigantic, bodies are not only subjected to the same convective influence as the air, but are also exposed to the upward force arising from a vertical blast. On each side of the track which marks the progress of the trunk, bodies are subjected to the confluent blasts, which rush in to supply the upward current.

The alternation of the convective and diruptive discharges was well exemplified in the phenomena of the Providence tornado of 1838, as described by a most worthy and well informed observer, Zachariah Allen, Esq. As soon as the trunk reached the river, the water throughout the included area, rose up as in a state of ebullition by the convective influence; but a diruptive discharge, in the form of lightning, taking place, the foam subsided momentarily, yet rose again, until by another spark of lightning another subsidence ensued. Were ever facts more accordant with an explanation than those observed by Mr. Allen, with the hypothesis which I advanced?

Against the idea that there could be any adequacy in the apparatus of nature, such as to make bodies dance between the earth and sky, as pup-

outer surface a conducting body be applied, and a due communication made with an electrical machine in operation.

As it is well known that the terrestrial surface is a conductor, it follows that in that surface, the denser air in proximity therewith, and the rarefied conducting air above, we have an electric between two conductors competent to act as coatings. Thus the dense air acts as a glass pane between two coatings, or as the glass in an exhausted globe acts between the rarefied air within and the hand of the operator without. We have, therefore, all that is requisite to the reception of an electrical charge.

That the means of disturbing of the electric equilibrium are abundantly prolific, the terrific discharges of lightning in electrical storms can leave no doubt.

Using the language of the Franklinian theory, I urged that, in the concentric spaces occupied by the earth and that occupied by the rare conducting medium above alluded to, there must be two oceans of electricity, which could not fail from mechanical or chemical causes to be in different states. But assuming that electricity is a result of the polarization of the ethereal fluid, to the undulation of which light is ascribed, we are led to substitute for oceans of a specific fluid, the idea of a boundless ocean of ethereal matter, which by peculiar affections may become competent to perform, within the concentric spaces alluded to, the part assigned by Franklin to one fluid, by Dufay to two fluids.

Consistently it may be inferred that an atmospheric charge may extend all around the globe, so as to make one great battery analogous to that above described of the exhausted glass globe; the rarefaction being in one case internal, in the other external. Agreeably to these considerations, there are no limits to the possible extent of atmospheric accumulations of electricity, while the rapidity with which discharges pervade conductors is such as to render distance no obstacle.

pets and pith-balls are seen to dance between electrified brass disks, it has been urged by Prof. Espy, that a stratum of an elastic fluid like air, could not perform the part of a solid metallic disk.

The answer to this is, that whatever state of things is competent to sustain electrical charges, is competent to produce any of the phenomena of *dis*charges. Just as much stability is requisite to enable the diruptive discharge of lightning to take place, as to enable the convective discharge of the tornado or water-spout.

To conclude, I claim to have laid before the scientific world a memoir, in which the tornado is made to bear the same relative position to lightning that the carrying discharge does to the electrical spark, and to have been the first electrician that ever pointed out this simple and true relation between those awful meteors. I urge that the language, proceedings, and reports of the French academicians show, that they were entirely unprepared for this new view of the subject. Hence, nearly five years afterwards, notwithstanding the tornado at Chatenay and Peltier's Report, and that I had sent them meanwhile a pamphlet containing a translation of my memoir into their own language, they still remained in utter darkness: but that meanwhile, Peltier, with the approbation of Arago, the President of the Academy, had adopted essentially my explanation; attempting, however, to put my theory in the back-ground, by substituting *conduction* for *convection*.

As I have elsewhere said, Franklin by aid of a kite-string demonstrated the identity of lightning with the electrical spark or diruptive discharge. I hope to have shown, by reasoning and a reference to experimental evidence, that the tornado is identical with the convective discharge of electricity.

On the State of Atmospheric Strata holding Accumulations of Electricity as in Thunder Storms.—In order to sustain the inferences which I have advanced, it is sufficient, as already avowed, to point out that no difficulty can be ascribed to the existence of an electrical accumulation competent to produce a convective discharge in the form of a tornado, which does not apply equally against any accumulation of the same nature, capable of producing diruptive discharges, as in the case of lightning. The precise mode in which a thunder cloud becomes a reservoir of electricity, and afterwards emits it as lightning, was not suggested by Franklin, and is still undecided. That this precision of explanation has not been attained in the case of the tornado, cannot then be fairly or consistently avowed as an objection to our considering this meteor as the offspring of the same parent.

If we strive to electrify a ball suspended to a steelyard or scale beam, as in Cuthbertson's electrometer, so as to be equiponderant with a counterweight on the other arm of the beam, it will descend as soon as charging commences. Wherefore, then, do not thunder clouds descend in obedience to an incipient charge? I believe this question has never been answered.

I would suggest that, agreeably to Faraday's researches, we are justified in supposing that as the charge consists more or less of the polarization of the aerial particles, by which they assume a certain arrangement

indispensable to an electrical charge, and which grows with its growth, and strengthens with its strength.

Thus there may be a simultaneous and commensurate affection, by which the opposite polarities, usually called the opposite electricities, created at the surfaces of the electrified (or, as I would say, polarized) stratum of the atmosphere, are produced together with that arrangement of the aerial atoms in rows, like iron filings situated between poles of a magnet. Hence the same electrifying causes which induce in the extreme surfaces a reciprocal attraction, cause in the intermediate atoms a proportional indisposition to undergo the derangement which any obedience to that attraction would involve.*

Objections to Espy's Hypothesis.—It is well known that, when suddenly rarefied, air is refrigerated; hence, when a receiver is first subjected to exhaustion, a cloud appears within it, arising from the condensation of aqueous vapor. Dalton found that when the air thus rarefied was devoid of aqueous vapor, it became much colder than when this vapor was present.

* If when there is a great accumulation of electricity, sufficient for the emission of lightning, we suppose the atmospheric stratum which holds the charge to perform the part of the glass in a charged pane, the cloud and the earth acting as coatings, the following rationale may be countenanced by the facts.

This rationale assumes that electricity consists of opposite polarities, resulting, as Faraday supposes, from an "*action*" of atoms in proximity, or as I infer, from a polar *affection* resulting from the polarization of etherial matter associated or combined with ponderable matter. The same reasoning would apply were the hypothesis of two fluids assumed, in which the phenomena are ascribed no less to repulsion than to attraction.

Let us suppose a stratum of the atmosphere to be situated just above the height of three miles, and of course to have only half the mean density of a stratum resting on the terrestrial surface. Let it be supposed that these strata are oppositely electrified, as in the case of thunder storms. Of course, the oppositely excited strata will have a tendency to approach each other, while the terrestrial surface, similarly electrified with the lower stratum, will repel this, simultaneously attracting the upper stratum. But will the attraction of the earth for the sparse and remote air of the upper stratum balance the repulsion exercised by it towards the contiguous and denser stratum below? Will not the force in the latter instance be greater, first, because, in the same space, there are twice as many atoms to repel, and in the next place, because they are in proximity to the earth? See *Silliman's Journal*, Vol. v., n. s., p. 345.

Again, while the similarly electrified aerial particles in either stratum must repel each other in consequence of their similar excitement, will not this effect in the lower stratum be twice as great, (if not quadruple,) in consequence of there being twice as many atoms in the same space? Thus while gravitation is counteracted by electrical repulsion, the gaseous elasticity of the air is increased by the same cause. Hence arises an expansive and ascensional power. Although the whole of the atmospheric stratum similarly electrified by the terrestrial surface must be repelled thereby, yet the force being equally distributed, is insufficient to cause the whole to be elevated so as to create a vacuum. It is under these circumstances that either the diruptive discharge may take place in the form of lightning, in which case an intermediate row of aerial particles become instrumental to the meeting of two opposite waves of electro-polarity; or a convective discharge may take place by a concentration of the forces on a comparatively minute columnar space. Within this space all the forces are exaggerated which have been assigned to the aggregate. Hence, while the aerial elasticity is assisted by a reciprocal electro-polar repulsion, the whole mass of the air and bodies within the space are violently repelled by the earth. Hence the expansive power by which houses are burst, and bodies, sufficiently light and movable, are borne aloft accompanied by an electrified aerial blast.

An exemplification of this concentration of force is to be seen in the perforation of the glass of a charged jar.

Were the mean height of the upper stratum only 1½ miles, the difference of density would be only one-fourth of that assumed, but still evidently there would be a diversity more than sufficient to account for the expansive and ascensional power.

This he ascribed to the latent heat given out by aqueous vapor on condensing. Before I had the pleasure of knowing Mr. Espy, I contrived an apparatus for showing the cold and cloud produced by rarefaction. *Silliman's Journal, Vol.* 13, *p.* 4.

This apparatus, as well as that employed by Dalton, does not differ essentially from Espy's nephelescope, which is the name given by him to an instrument answering the same purpose as that employed by Dalton. Notoriously, the density of the air diminishes, in a geometrical ratio, as the place of examination is higher; so that at the altitude of three miles it is only half as dense as upon the earth's surface.

Davy, in his elements, ascribed the formation of clouds to the refrigeration arising from the rarefaction of ascending columns of air, and to this I used to advert in my lectures, nearly thirty years ago, using the nephelescope, which I had contrived, as above mentioned, to illustrate the idea.

Thus it became evident, from the experiments and suggestions of Dalton and Davy, that when the different portions of air, in an upward current, successively reach a height sufficient to rarefy and cool them to a certain extent, the aqueous vapor which they hold must form a cloud, and at the same time render them lighter and warmer than the surrounding air.

It was first assumed by Espy that the rise of temperature thus caused, would create a buoyancy like that of a balloon, and an upward force, and so great an acceleration as to produce the phenomena of a tornado at the foot of the column affected. In fact, the buoyancy thus arising is, by this ingenious author, considered as universally the cause of storms.

Admitting his estimate of the buoyancy consequent to the condensation of vapor to be correct, I aver that no buoyancy thus created in the upper part of an aerial column, would cause any disturbance of the column below the level of that upper part.

Count Rumford first showed that water may be boiled at the top of a containing vessel without warming the liquid lying below the part where the heat may be applied. This fact has been demonstrated by me on a large scale during each of thirty courses of lectures. *In Mr. Espy's presence*, about five years ago, I demonstrated that this law is equally true in the case of air.

A large bell-glass was so supported in an inverted position, as to allow the axis of a spirit lamp flame to be concentric with the bore of the neck. In the next place, a tuft of cotton, nearly equalling in diameter the mouth of the bell, was moistened with alcohol. By means of tongs, this tuft, being held just above the mouth of the bell, was inflamed. Of course, the difference of temperature thus created was incomparably greater than any which could be producible by the latent heat yielded by condensing vapor. Moreover, the whole lifting influence was concentrated upon the comparatively narrow area of the bore in the neck; yet the smallest acceleration could not be perceived to take place. The flame was not in the slightest degree disturbed. Subsequently, at the meeting of the association at Cambridge, in 1849, an apparatus was constructed by which the experiment above described, was repeated with an improved arrangement.

Inside of the inverted bell, so as to cover the bore of the neck imme-

diately over which it rested, a disk of wire gauze was placed, supporting a few thin fibres of carded cotton. About half an inch above the mouth of the bell another disk or tray of wire gauze was upheld by appropriate means, on which there was put a stratum of carded cotton sufficiently copious. These preparations being completed, the cotton above the bell was ignited. Notwithstanding the enormous rise of temperature thus produced in the upper part of the column of air, of which the lower portion occupied the bell glass, so entirely was this lower portion uninfluenced that there was not the least perceptible agitation produced among the most delicate fibres of the cotton.

This perfect immobility of the air subjacent to a column of that fluid, to which a great ascensional power seems to be imparted by the ignition of the cotton, as above described, will not exite wonder, when it is recollected that the buoyancy is not the consequence of absolute levity, but of comparatively lesser weight. The ascent of a balloon is not spontaneous; it is the effect of coercion. It is forced to ascend by the superior gravity and consequent pressure of the surrounding air. But while this displaces the balloon, it does not, on that account, relax its pressure on the subjacent portion of the atmosphere.

It is admitted, that, on reaching the rarefied region where the atmospheric clouds appear, the consequent condensation of aqueous vapor will make any body of air containing it warmer than it would otherwise be, and from the lowest level above which the heat is applied there would be a more or less disturbance, in consequence of the greater buoyancy of the column warmed by the condensation of vapor. But this disturbance would, as I conceive, be much less abrupt and forcible than the Espyan hypothesis of storms requires.

Even after the condensation of aqueous vapor is effected, the water which formed it will remain within the column, and still add to its weight, so that the total weight will not be diminished. Moreover, by swelling upwards, as it naturally will do, towards the region where there is least resistance, it will become as much taller as rarer, and thus compensate by its greater height for the loss of specific gravity. In a non-elastic fluid, any superiority of elevation, in any portion expanded more than the rest, would be rapidly compensated by the overflow of the excess; but in an elastic fluid, where the summit must be so rare as to have scarcely any perceptible weight, no such active overflow can take place as would be requisite to produce any violent exchange of position between the column thus affected and the surrounding portion of the atmosphere.

If, as represented by Espy, all that is requisite to produce a tornado is an upward current of air, pre-eminently warm and moist, and penetrating into the region of the clouds, the conditions are abundantly realized in the vicinity of the equator. The trade winds have long been ascribed to the ascent of air from the regions on each side of the equatorial line, in consequence of the rarefaction arising from a comparatively superior temperature.

To supply the vertical current thus created, the air is conceived to flow towards the equator from regions more remote, and less heated by the sun; the currents thus caused being rendered more westerly in their direction, relatively to the earth's surface, by the diurnal motion of that

surface, which is necessarily accelerated with the increase of its distance from the terrestrial axis, as the equator is approached. As, in consequence of the warmth to which its ascent is attributed, and an ample contact with the surface, the upward current must be replete with aqueous vapor, all the requisites which the Espyan theory requires for the production of a perpetual gigantic tornado are present; and yet none is produced.

With the hypothesis which ascribes tornados to an electrical discharge, it is quite consistent that there should be no thunder storms within the region of the vertical current, or the trade winds produced thereby, since there is a perpetual discharge by convection, preventing of course any electrical accumulations.

On Certain Points in the Construction of Marine Boilers. By J. Scott Russell, M. Inst. C. E.*

The author having arrived at certain theoretical results relative to the construction of marine boilers, put them into practice about ten years back, in designing the boilers for the Royal Mail Steam Packets *Clyde*, *Tay*, *Tweed*, and *Teviot;* and as they had been in constant work ever since, running from 42,000 miles to 48,000 miles per annum, without material repairs, he believed their durability, combined with effective combustion and economy of fuel, had been fully established. The principles upon which these boilers were constructed differed from those generally recognised. In the first place, it was considered that a judicious distribution of the most intensely heated surfaces would be conducive to durability; and for this purpose, instead of returning the flues over the furnaces, the top of the furnaces and the hottest flues were brought to the surface of the water, and the cooler or return flues were taken to the bottom of the water. The water was admitted at the bottom, and was gradually warmed as it rose, the greatest heat being imparted at the last moment, by which means the bubbles of steam were prevented from accumulating in contact with intensely heated metal. In the next place, the capacity of the furnaces or fire-boxes was unusually large, and their height above the incandescent fuel much greater than usual. The evaporating surface in these boilers was also much more than customary, there being no less than three feet of evaporating surface for every foot of furnace bars. The process of blowing off was provided for by arranging under the flues and furnaces large water spaces, as reservoirs for the collection and blowing off of brine and other deposit.—*Proceed. Inst. Civ. Eng.*, *March* 23.

A Description of a Diaphragm Steam Generator. By M. Boutigny (d'Evreux).†

The principle upon which this steam generator was based, was that "bodies evaporate only from their surfaces." This being received as an axiom, it must necessarily follow that in the construction of steam boilers,

* From the London Civil Engineer and Architect's Journal, April, 1852. † Ibid.

either the evaporating surface of metal should be extended to its utmost limit, or the water should be so divided, and its evaporating surfaces be so multiplied, as to arrive at the same end, of obtaining the greatest amount of steam by the expenditure of the least amount of fuel. The steam generator was described to consist of a vertical cylinder of wrought iron, 25 inches high by 12⅝ inches diameter; the base terminating in a hemispherical end, and the upper part closed by a curved lid, upon which was attached the usual steam and safety valves, feed, steam, and other pipes, &c. The interior contained a series of diaphragms of wrought iron, pierced with a number of fine holes, and having alternately convex and concave surfaces. They were suspended by three iron rods, at given distances apart, in such a manner as not to be in contact with the heated exterior, or shell of the boiler. When any water was admitted through the feed-pipe, it fell upon the upper (convex) disk, which had a tendency to spread it to the periphery, the largest quantity falling through the perforations in the shape of globules; the second diaphragm being concave, tended to direct the fluid from the circumference to the centre, and so on, until, if any fluid reached the bottom of the cylinder, it mingled with a thin film of water, in a high state of ebullition, that being the hottest part of the boiler. It appeared, however, that in its transit through these diaphragms, the water was so divided, that exposing a very large surface to the caloric, it was transformed into steam with great rapidity, and with great economy of fuel. The boiler described had been worked for a long time at Paris with great success, giving motion to a steam engine of two horse power. The consumption of coal was stated to be very small, 789 pounds of water having been converted into steam by 182 pounds of coal in nine hours, under a pressure of ten atmospheres. The chemical part of the question was carefully examined, and it was shown, that at that temperature the iron was exactly in the best condition to bear strain. The practical application on a large scale was submitted to the engineers, the author having only proposed the system for small boilers, and under circumstances of wanting to obtain a motive power in situations of restricted space, and where first cost was a great object.—*Proceed. Inst. Civ. Eng., March* 23.

For the Journal of the Franklin Institute.

On the Telegraphic Lines of the World. By Dr. L. Turnbull.

United States.

In giving an account of the number of telegraphic lines, it will be proper to place the United States as first on the list, from the number and extent of the lines, and from the extensive use made of them in every department, both for business and pleasure. Still, it will be but an approximation to the number, for they are like the spider's web, forming a complete network over the length and breadth of the land, from the extreme north-eastern point to the western boundary of Missouri, adjoining the Indian territory. A continuous line of telegraph now extends from the verge of civilization on the western frontier (east

of the Rocky Mountains) to the north-eastern extremity of the United States; and the time is not far distant when we shall have a telegraph from the Mississippi river to San Francisco. This is no fancy sketch, as the route is already selected for the California line, and a most interesting Report was presented to the Senate of the United States in the session of 1851, by the Committee on Post Offices and Post Roads.

"The route selected by the Committee is, according to the survey of Captain W. W. Chapman, U. S. Army, one of the best that could be adopted, possessing as it does great local advantages. It will commence at the City of Natchez, in the State of Mississippi, running through a well settled portion of Northern Texas, to the town of El Paso, on the Rio Grande, in latitude 32°; thence to the junction of the Gila and Colorado rivers, crossing at the head of the Gulf of California, to San Diego, on the Pacific; thence along the Coast to Monterey and San Francisco. By this route, the whole line between the Mississippi River and Pacific Ocean will be south of latitude 33°; consequently, almost entirely free from the great difficulties to be encountered, owing to the snow and ice on the Northern route, by the way of the South Pass, crossing the Sierra Nevada Mountains in latitude 39°. The whole distance from the Mississippi to San Francisco will be about 2400 miles."

The great benefits to be derived, the Report fully and ably sets forth, whether in a military, commercial, or social point of view.

"In a commercial point of view, the line in question assumes a gigantic importance, and presents itself not only in the attitude of a means of communication between the opposite extremes of a single country, however great, but as a channel for imparting knowledge between distant parts of the earth. With the existing facilities, it requires months to convey information from the sunny climes of the East to the less favored, in point of climate, but not less important regions of the West, teeming as they do, with the products of art and enterprise. Let this line of wires be established, and the Pacific and Atlantic Oceans become as one, and intelligence will be conveyed from London to India in a shorter time than was required ten years since to transmit a letter from New York to Liverpool."

"Nor does the importance of the undertaking claim less interest, when regarded in a social point of view. California is being peopled daily and hourly by our friends, our kindred, and our political brethren. The little bands that a few centuries since landed on the Western shores of the Atlantic, have now become a mighty nation. The tide of population has been rolling onward, increasing as it approached the setting sun, until at length our people look abroad upon the Pacific, and have their homes almost within sight of the spice groves of Japan. Although separated from us by thousands of miles of distance, they will be again restored to us in feeling, and still present to our affections, through the help of this noiseless tenant of the wilderness."

In the Congressional *Globe* of April 6, 1852, Mr. Douglass presented the memorial of Henry O'Reilly, proposing a system of intercommunication by mail and telegraph, between the Atlantic and Pacific States. All he asks is permission to establish a telegraphic line from the Mississippi Valley, where the wires now terminate, to the Pacific Ocean, and to be

protected by a line of military posts, so that he can keep up the communication for the benefit both of the Government and of the public. Mr. O'Reilly states in this memorial, that within two years from this time, with this line completed, he would be able to deliver the European news on the shores of the Pacific within one week from the time it left the European Continent. The motion was referred to the Committee on Territories.

These are but a part of the advantages set forth in the bill, with a strong recommendation from the Committee for its passage.

The authorities of Newfoundland have granted to Mr. H. B. Tibbatts and associates, of New York, the exclusive right to construct and use the magnetic telegraph across that island, for the period of thirty years. The grant is designed to facilitate Mr. Tibbatts in his scheme for the establishment of steam and telegraphic communication between New York and Liverpool or London, *in five days*. The telegraph is to extend from New York to St. Johns, from whence a line of steamers is to run to Galway, where another line of telegraph is to commence, extending to London. This latter line will, it is said, be completed during the current year. The distance from St. Johns to Galway is 1647 miles, or about five days' sail.

There are numerous lines in actual and successful operation under the title of Morse, House, and Bain, each giving every facility to the business man.

A recent letter from Charles T. Chester, Esq., Telegraphic Engineer, who is connected with the Morse Line, the first and most extensive one in the United States, gives the following statistics of the facilities for the transmission of intelligence along their lines in the chief cities of this country.

"Two Morse wires run to Boston, three to Buffalo, five to Philadelphia, four to Washington, and two on to New Orleans; on the Western and Canada routes there is generally but one."

The above list will give an approximation of the number of the Morse lines, obtained principally from Mr. Chester, and from the work of Disturnell, published January, 1852. The following is a list of the names of the Companies:

1. Washington and New Orleans Telegraph, organized under Morse's patent; tariff of charges, $2; from Washington to New Orleans, 1716 miles, with 19 stations; no charge for address, signature, or date; Daniel Griffin, Esq., President.

2. Atlantic and Ohio Telegraph Line; Philadelphia office, 101 Chesnut street; tariff of charges, $1·30 to Milwaukie, Wis.; from Philadelphia to Milwaukie, 812 miles, with 76 stations.

3. The Magnetic Telegraph Company Line, extending from New York to Washington City; office, No. 5, Hanover street, corner of Beaver street, New York; rates of charges, 50 cents; from New York to Washington, 245 miles, with 10 stations. Also, from New York to New Orleans, $2·50; but when a communication exceeds 100 words, the price on all words exceeding that number will be reduced one-third.

4. New York, Albany, and Buffalo Telegraph; office, No. 16, Wall street, New York, up stairs; from New York to Niagara, 500 miles; 65 cents. This line connects with numerous towns and cities in Vermont, Canada, Pennsylvania, Ohio, Michigan, Indiana, Illinois, Wisconsin, Iowa, Tennessee, and Kentucky; with 76 stations.

5. Troy and Canada Telegraph; from Troy to Montreal, with 14 stations.

6. Magnetic Telegraph Line, from Boston to Halifax, N. S., with 12 stations.

7. New York and Boston Magnetic Telegraph Association, organized under Morse's patent; office, No. 5, Hanover street, near Beaver street, New York; from Boston, Mass., to Halifax, N. S.; with 35 stations. Also, from New York, via Bridgeport, to Birmingham, Conn.; with 11 stations; 50 cents for 10 words.

The first American telegraphic line was established in May, 1844, between Washington and Baltimore, over a length of 40 miles.

The line from Washington to Baltimore also proceeds to Philadelphia and New York, over an extent of 250 miles. It reached Boston in 1845, and became the great line of the North, from which branched two others: one, the length of 1000 miles, from Philadelphia to Harrisburg, Lancaster, Pittsburg, Ohio, Columbus, Cincinnati, Louisville (Kentucky), and St. Louis (Missouri); the other, the length of 1300 miles, from New York to Albany, Troy, Utica, Rochester, Buffalo, Erie, Cleveland (Ohio), Chicago (Illinois), and Milwaukie (Wisconsin).

A fourth line goes from Buffalo to Lockport, Queenstown, the Lakes Ontario and Erie, the Cataracts of Niagara, Toronto, Kingston, Montreal, Quebec, Halifax, and the Atlantic Ocean, over an extent of 1395 miles.

Two lines South; one from Columbus to New Orleans, by Cincinnati; the other from Washington to New Orleans, by Fredericksburg, Charleston, Savannah, and Mobile. The first is 1200 miles long, the second 1122 miles. This line has been extended West to Independence, Missouri.

In April, 1852, direct communication was had between the New Orleans Telegraph office and the office of the New Orleans line in Hanover street, New York, the whole extent of near 3000 miles of wire having been successfully worked in a single circuit. Despatches were sent from New York to New Orleans sixty minutes ahead of time.

The House Printing Telegraph has only been in operation since 1846, but even in that short time has spread itself over a large portion of the United States, working to the entire satisfaction of our business community, and wherever found, exciting the admiration of the curious, being able to print in Roman capitals communications in almost every language.

This line consists of the Boston and New York Telegraph Company, using the House Printing Telegraph; about 600 miles of wire, two wires; stations at Boston, Mass.; Providence, R. I.; Springfield, Mass.; Hartford, Conn.; New Haven, and New York.

A line is being constructed to connect with this Boston line, running from Springfield, Mass., to Albany, N. Y.; there to intersect the New York and Buffalo line, using the same instruments, extending from New York to Buffalo, a distance of 570 miles. One wire is now in operation, connecting with Poughkeepsie, Troy, Albany, Utica, Syracuse, Lyons, Rochester, Albion, Lockport, and Buffalo; and another wire, nearly completed the same distance. This line is to continue to St. Louis, Mo., connecting with Cleveland, Cincinnati, Louisville, and St. Louis, which will be completed the entire distance in 1852; forming the longest line in the

world under the direction of one company, the whole length being 1500 miles.

The New Jersey Magnetic Telegraph Company, using the House instruments, and the first line of this kind ever put in operation, extends from Philadelphia to New York; one wire, 132 miles; and another now being put up. For this information, I am indebted to the politeness of William J. Philips, Esq., Telegraphic Engineer on the House line at Philadelphia.

Making the whole number of miles 2802; rate, 25 cents for the first ten words from Philadelphia to New York.

The Atlantic and Pacific Telegraph range, under the arrangement of Henry O'Reilly, Esq., using a modification of Bain's Chemical Telegraph and Morse's instrument, from New York to Washington, and from New York to Boston. Also, the first division, constructed eastward of the Mississippi, known as the "Atlantic, Lake, and Mississippi Telegraph," extending to the Atlantic, and connecting nearly all principal cities and towns between the Canadian frontier and the Mexican Gulf—embracing the Ohio and Mississippi vallies, as well as the Lake country; about 6000 miles constructed, and 3000 miles contracted for construction.

The second division, westward of the Mississippi, to include the "Mississippi and Pacific Telegraph," of which about 500 miles of river distance, embracing the principal towns along the Missouri, between St. Louis and Fort Leavenworth, is contracted for construction, additional to other extensions in different quarters, west of the Mississippi, to be extended from Fort Leavenworth to San Francisco, when Congress authorizes the extension through the public domain.

The Bain Line, now a Morse Line, Mr. Henry J. Rodgers, General Superintendant from New York to Washington, has lately constructed, at an expense of $10,000, spars 310 feet high, at the Palisades and Fort Washington, ten miles above the City of New York, for the purpose of sustaining their wires over the river, instead of the method formerly employed, by passing the current through the water, by wires laid across the North River. He considers this method, by means of suspension on spars, as being more permanent and durable. The price of telegraphic despatches by this line is the same as the others. They have offices in Boston, Providence, New York, Philadelphia, Wilmington, Baltimore, and Washington.

The Bain Lines in the United States are as follows:

One from Louisville to Memphis, called an O'Reilly Line, and contemplate using the same instrument to New Orleans on the same line.

One from New York to Boston; 2 wires.

One from Boston to Portland, Me.

And one from New York to Buffalo; 2 wires.

The profits to the stockholders amount to from three to six per cent. per annum. The usual expense of constructing these lines varies from $100 to $200 per mile.

List of the Morse Telegraph Lines in the United States.

	MILES.
1. Washington to New Orleans, by way of Richmond, Va.,	1,716
2. Washington to New York, by way of Baltimore and Philadelphia, 5 lines, each 250 miles,	1,250
3. Harper's Ferry to Winchester, Va.,	32
4. Baltimore, by way of Pittsburg and Wheeling, to Cumberland,	324
5. Baltimore to Harrisburg, by way of York, Pa.,	72
6. York to Lancaster, by way of Columbia, Pa.,	22
7. Philadelphia to Lewistown, Del.,	12
8. Philadelphia to New York, 6 lines, each 120 miles,	720
9. Philadelphia to Pittsburg, by way of Harrisburg,	309
10. Philadelphia to Pottsville, by way of Reading,	98
11. Reading to Harrisburg,	51
12. New York to Boston, by way of New Haven, &c., 2 lines, each 240 miles,	480
13. New York to Buffalo, by way of Troy and Albany, 5 lines, each 500 miles,	2,500
14. New York to Fredonia, N. Y., by way of Lake Erie, Newburg, and Oswego,	450
15. Bridgeport, Conn., to Bennington, Vt., by way of Pittsfield,	150
16. Boston to Newburyport, by way of Salem, Mass.,	34
17. Boston to Portland, by way of Dover,	110
18. Worcester to New Bedford, by way of Providence,	97
19. Worcester to New London, by way of Norwich,	74
20. Portland to Calais, Me.,	260
21. Calais to St. Johns, N. B.,	75
22. Troy to Whitehall, by way of Salem,	72
23. Troy to Montreal, Canada, by way of Rutland and Burlington,	278
24. Syracuse to Oswego, N. Y.,	38
25. Auburn to Elmira, by way of Ithaca, N. Y.,	75
26. Binghampton to Ithaca, by way of Oswego, N. Y.,	48
27. Buffalo to Queenston, Canada, by way of Lockport,	48
28. Buffalo to Milwaukie, Wis., by way of Lake Erie and Chicago, Ill.,	812
29. Queenston to Montreal, by way of Toronto and Kingston,	466
30. Montreal to Quebec,	180
31. Cleveland to Pittsburg, by way of Alton, Ill.,	150
32. Pittsburg to Cincinnati, O., by way of Columbus,	310
33. Pittsburg to Columbus,	680
34. Columbia to Memphis, Tenn., by way of Wheeling,	205
35. Columbia to New Orleans, by way of Tuscumbia and Natchez,	638
36. New Orleans to Balize, at the mouth of the Mississippi,	90
37. Columbia to Chilicothe, Ohio,	45
38. Cincinnati, Ohio, to Maysville, Ky., by way of Ripley,	60
39. Cincinnati to St. Louis, Mo., by way of Vincennes,	410
40. St. Louis to Chicago, by way of Alton, Ill.,	330
41. Alton to Galena, by way of Quincy,	380
42. Quebec to Halifax,	700
43. St Louis to Independence, Mo.,	25
44. New York to New Orleans,	3,000
Total,	17,283

Making in all the lines—

House Line,	2,802 miles.
O'Reilly Line, using in most of the offices the modified Bain instrument—part of the O'Reilly Lines using the Morse instrument,	6,000 "
Morse Line,	17,283 "
Bain Line,	1,092 "
Total number of miles in the United States,	27,177

(To be Continued.)

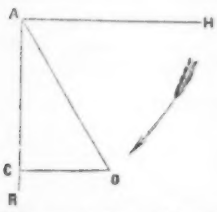
For the Journal of the Franklin Institute.

On Oblique Action. By T. W. Bakewell, Esq.

In the following remarks, "loss of power" means inefficient consumption of steam; in other words, power and steam are used synonymously.

A *gain* of power by any obliquity of forces (or vision,) has ceased to be orthodox; but a *loss* therefrom still lingers as canonical.

A loss of power is ascribed to oblique action on the water in some positions of the arm of side wheel steamers; and truly, there is a small loss by oblique over direct action on the water which will be noticed below; but that is not the loss in question.



Let A R be the vertical arm of the wheel, pressed by the force from the engine, against an unyielding object at R; the advance of the vessel would be the measure of the power or steam used.

Let A H be the horizontal arm, opposed at H by an unyielding object; then, as there is no advance of the vessel, no power is used, and no mechanical effect produced.

Hence, it is evident, that at any position between the vertical and horizontal, the arm being in like manner opposed by an unyielding object; the expenditure of steam would be restricted to that part of the force tending to propel the vessel, and the other portion tending to raise the vessel would be reserved.

The reservation of steam, implies a *pro tanto* loss of time, and although not the point under discussion, may bear a remark. The course of action with a crank and connecting rod, shortening the leverage as the dead point is approached, is precisely similar to the mode of decrease of propelling power as the arm of the wheel approaches its dead point at A H.

This apparent loss of time by the retention of steam, is with the wheel as with the crank, obviated simply by the steam "getting stronger."

An oblique arm cannot annihilate or dispose of the power given out to it by the engine, except by advance of the vessel, or slip of the paddle; otherwise, we might anchor a vessel in the current, and make the wheel the motor to the cylinder converted into a double acting force pump; when that position of the former power from the cylinder which was nullified by obliquity, would become a gain to the wheel of equal amount.

The loss in practice which occurs from oblique action, arises from the loss by slip of the paddle through the water becoming *proportionably* greater, as the propelling part of the force decreases by obliquity.

The loss from this source is dependent on size of wheel and paddle, force applied, &c., and the following merely exhibits the governing principle:

The propelling effect is as the cosine directly, and the loss by slip, as the cosine inversely, where A R, radius = 1; then to the vertical arm A R, with a propelling effect = 1, there is a loss by slip of say 20 per cent. to the oblique arm A O, (at 30°); with a propelling effect as cosine A C = ·866, there would be a proportional loss of 23 per cent. In actual

practice, however, the above increase of 3 per cent. loss, seemingly due to the oblique arm, is much reduced by partial immersion, and by the reciprocally neutralizing motions of the wheel backwards, and the vessel forwards, causing the paddle to enter the water nearly edgewise, and to be withdrawn in the same manner after passing the vertical.

A frequent contributor to the Journal on this subject, in giving details of marine engines and their effects, generally places the loss by oblique action in side wheel steamers (exclusive of slip,) at 12 to 17 per cent., but in similar details with screw propellers where the action is entirely oblique, this item is omitted.

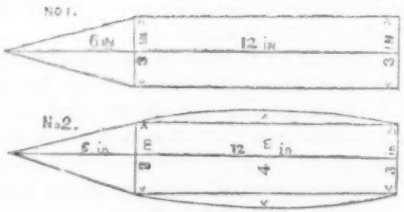
Cincinnati, June, 1852.

Hints on the Principles which should regulate the Forms of Boats and Ships, derived from original Experiments. By Mr. William Bland, *of Sittingbourne, Kent.**

Continued from vol. xxiii, page 358.

Chapter VII.—Experiments relating to the Middle.

The segment of a circle, which subtends ¼-inch in the centre of a base line of 6 inches, having proved beneficial towards the promotion of speed when applied at the bows, as given in Experiment 10, and at the stern in Experiment 24, induced a further trial of the same curve in the experiments annexed:



Scale, ½-inch to 1 inch.

Experiment 28.—The two models (Nos. 1 and 2) of the same bows, length, and weight, but differing in their sides, one being parallel, the other convexed; the rise at mid-length being ½-inch to the whole length of side of 12 inches, according to the proportions before adopted.

Upon being tried against each other at the ends of the balance-rod, it appeared that the speeds were equal. This makes a third instance of the good qualities of the curve in the promotion of speed over the straight line.

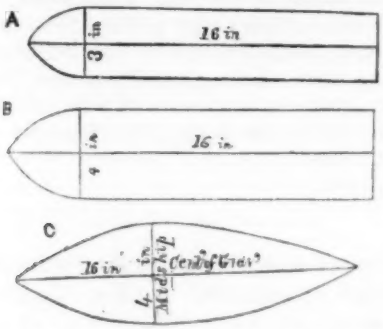
In this experiment is seen greater breadth of beam, equal indeed to one-fourth; yet, by the adoption of the curve in question, equal speed is obtained.

Experiment 29.—Segments of circles of different diameters were further applied and tested against two parallel-sided models; one of the same

* From the London Architect for September, 1851.

breadth of beam, the other of less beam by one-fourth part; all three, however, of the same weight, 23 oz.

Scale, $\frac{1}{8}$-inch to 1 inch; thickness, 2 inches.



Modelled from the horizontal section of the sole fish.

The first trial took place between the models A and C. The result gave the speed of C to be greater than A, in the proportion of 5 : 4; or taken in weight, equal to 8 oz.; because the model C required to be loaded with that weight extra, to retard its speed to an equality with the speed of A.

Experiment 30.—The second trial was between the models A and B. In this instance, the speed of A beat that of B, by the extra weight of 4 oz.

Experiment 31.—In the third trial, the speed of the model C beat that of the model B, by 12 oz. extra weight.

Experiment 32.—The model C was drawn through the water, having its stern or sharper end foremost, and in consequence of so doing, the speed was reduced. Moreover, by the sharper end going foremost, the steadiness of its course was in a great measure destroyed, the model requiring a piece of keel to be attached at the aft end to cause the body to preserve a straight course; and which was not found necessary when the bluffer end or bows met the water when floating upon an even keel.

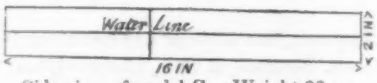
The inference to be drawn from the last four experiments is in every respect in favor of the bird or duck shaped model C; at the same time pointing out the wisdom of preferring the bluffer or larger end to go foremost, rather than the sharper end.

Chapter VIII.

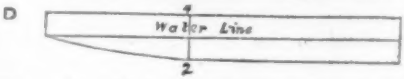
The subjoined experiments were undertaken to ascertain the effects of cutting inclined up of vessels from the midship section, both to the head and stern. To this end, three models were made of the precise form and size of C in the preceding chapter, with the exception of their being varied from it as delineated below, scale $\frac{1}{8}$-inch to 1 inch.

The inclination upwards, or curves at both the bows and stern of these diagrams, are sections of two circles, having their centres in the same straight line (numbered 2, 4,) at the midship sections of the diagrams, when produced indefinitely in the direction of 2, 4; and their circumferences passing through the points 1 and 2, 2 and 3.

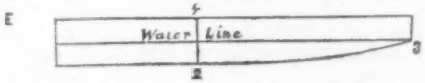
Experiment 33.—The models C and D being first made of equal weight, were tested as to their speed; and it was found that the model D with its bows cut inclined up, beat C with the level bottom by 8 oz. additional weight.



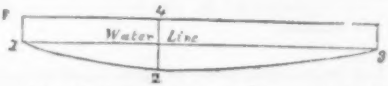
Side view of model C.—Weight 22 oz.



The model with the bows from 1 to 2, cut inclined up.



The model with the stern from 2 to 3, cut inclined up.



The model with both the bows and stern cut inclined up.

Experiment 34.—Next, the model C was tested with E, having its stern cut inclined up; when C was again beaten in its speed, the model E carrying with equal speed 6 oz. extra weight.

Experiment 35.—After this, the two models D and E were tried against each other, and the advantage in speed was, in weight, 2 oz. on the side of the model D.

Experiment 36.—Lastly, the models C and F were put upon the water together, the latter having both its bows and stern cut inclined up. The difference in their speed was altogether in favor of F; indeed, equal to 12 oz. or more, for this extra weight was not sufficient when put into F, to equalize the speed of the two models, but the great weight F already carried was quite load enough, without sinking too deep into the water.

The conclusion to be drawn here is, the positive good effects from the cutting or curving up of both the head and stern of vessels, when commenced from the midship section, and extending as far at least, each way, as the load water-line.

(To be Continued.)

For the Journal of the Franklin Institute.

Notes on the U. S. Surveying Steamer Walker. By B. F. Isherwood, Chief Engineer, U. S. Navy.—(*With a Plate.*)

The *Walker* was one of the batch of eight iron revenue steamers, commenced in 1843, for the Treasury Department. She was built at Pittsburg, Pennsylvania, by J. Tomlinson, and was one of the two originally fitted with paddle wheels. The experiment tried by the Treasury, of substituting steam for sailing cutters, having signally failed from the too large size of the steamers, the expense of maintaining them, and the

abortive character of their machinery and propelling instruments, they were either turned over to the Coast Survey, or otherwise disposed of. Of the eight, only three now remain in the Government service, viz: the *Legarè*, the *Bibb*, and the *Walker*, and they are employed as Surveying Steamers.

During the present year, the *Walker* has been refitted with new boilers at the works of Messrs. Merrick & Son, Philadelphia. The dimensions of the vessel, machinery, &c., are now as follows:

HULL.

Length between perpendiculars,	132 feet.
Beam extreme,	24 " 6 inches.
Depth of hold,	11 " 3
Mean draft of water for all the steaming done,	9 " 8
Burthen,	305 tons.
Immersed amidship section at 9¾ feet draft,	193 square feet.
Square feet of immersed amidship section, per cubic foot of space displacement of pistons,	2·708 to 1·000
Square feet of immersed amidship section, per cubic foot of space displacement of pistons, multiplied by number (22) of double strokes of piston per minute,	0·123 to 1·000

ENGINES.

Two horizontal, half beam, condensing engines, Lighthall's patent.

Diameter of steam cylinders,	2 feet 9 inches.
Stroke of steam piston,	6 "
Diameter of air pumps,	2 " 8 "
Stroke of air pump piston,	1 " 4 "
Space displacement of steam pistons per stroke,	71·274 cubic feet.
Space displacement of air pump pistons per stroke,	14·893 " "
Mean effective pressure by indicator on piston per square inch, (steam pressure in boiler 11·3 pounds, cutting off at half stroke, throttle one-third open, being average of all steaming done,)	13¼ pounds.
Double strokes of piston under above conditions per minute,	22
Horses power developed by engines under above conditions,	181·26

PADDLE WHEELS.

Diameter from outside to outside of paddles,	16 feet.
Length of paddle,	6 "
Breadth of paddle,	2 "
Immersion of lower edge of paddle at 9¾ feet draft of vessel,	4 "
Area of two paddles,	24 "
Number of paddles in each wheel,	12 "
Number of paddles in each wheel in water at 9¾ feet draft of vessel,	3 "
Proportion of the area of two paddles to immersed amidship section of hull,	1.000 to 8·042
Proportion of the area of all the immersed paddles to immersed amidship section of hull,	1.000 to 2·681
Loss of effect by oblique action of the paddles, calculated as the squares of the sines of their angles of incidence on the water,	21·64 per cent.
Slip of centre effort of paddles with 22 revolutions of wheels per minute, and 7 knots speed of vessel,	30·38 per cent.

BOILERS. *Plate I.*

Two iron boilers with single return ascending flues; boilers placed side by side.

Length of each boiler, (exclusive of projection of steam chimney=7 inches,)	15 feet 2 inches.
Breadth of each boiler, (exclusive of projection of steam chimney=8 inches,)	7 " 0 "
Height of each boiler, (exclusive of additional height of steam chimney=6 feet 7 inches,)	9 " 3 "
Contents of circumscribing parallelogram of each boiler, (exclusive of steam chimney,)	982·04 cubic feet.

Total area of grate surface in both boilers,	57·5 square feet.
Total area of heating surface in both boilers,	1280· "
Capacity of steam room in both boilers and steam chimney,	541· cubic feet.
Capacity of steam room in boilers, steam chimney, and steam pipe,	570· "
Cross area of the lower row of flues in both boilers,	10·123 sq. feet.
Cross area of the two upper rows of flues in both boilers,	13·090 "
Cross area of smoke pipe,	12·566 "
Height of smoke pipe above grates,	40 feet.
Mean pressure of steam above atmosphere in boiler per square inch, throttle ¼d open, cutting off at ½, making 22 double strokes of piston per minute, giving 7 knots speed to vessel, being the general average of all steaming done,	11·3 pounds.
Mean initial pressure of steam in cylinder per square inch above atmosphere by indicator under above conditions,	6·3 "
Space comprised between cut-off valve and piston, (both cylin's,)	8·563 cu. feet.
Consumption of anthracite coal per hour, with very moderate fan blast, under above conditions,	840 pounds.

PROPORTIONS.

Proportion of heating to grate surface,	22·261 to 1·000
" grate surface to cross area of lower row of flues,	5·681 "
" " " the two upper rows of flues,	4·393 "
" " " smoke pipe,	4·576 "
" heating surface to cross area of lower row of flues,	126·445 "
" " " the two upper rows of flues,	97·784 "
" " " smoke pipe,	101·862 "
Square feet of heating surface per cubic foot of space displacement of pistons,	17·958
Square feet of heating surface per cubic foot of space displacement of pistons per double stroke of piston (22) per minute,	0·816
Square feet of grate surface per cubic foot of space displacement of pistons,	0·807
Square feet of grate surface per cubic foot of space displacement of pistons per double stroke of piston (22) per minute,	0·037
Cubic feet of steam room per cubic foot of steam used per stroke of pistons,	12·900
Consumption of anthracite coal with very moderate fan blast per square foot of grate surface per hour,	14·609 pounds.
Consumption of anthracite coal with very moderate fan blast per square foot of heating surface per hour,	0·656 "
Weight of steam produced per hour from water at a temperature of 100° F., by one pound of anthracite coal, exclusive of the steam required to work the fan blast, but inclusive of loss by blowing off, so as to keep the sea water at twice the natural density, of loss in nozzles, clearance, &c., taking the total cylinder pressure at 21 pounds per square inch, cutting off at half stroke, making 22 double strokes of pistons per minute, and burning 840 pounds anthracite per hour,	8·008 "
Weight of steam produced per hour from one square foot of heating surface under above conditions,	5·255 "

PERFORMANCE.

The general mean of all steaming done at sea is, per hour, 7 knots of 6082⅔ feet each—a very low speed, when the consumption of fuel (840 pounds of anthracite per hour) is considered, in connexion with the dimensions of the vessel. A portion of this low result is undoubtedly due to the proportions of the wheel, which are of the common radial kind, and which, with a radius of only 8 feet, have the enormous immersion of 4 feet. When the vessel is rolling in an ordinary sea, or when she is

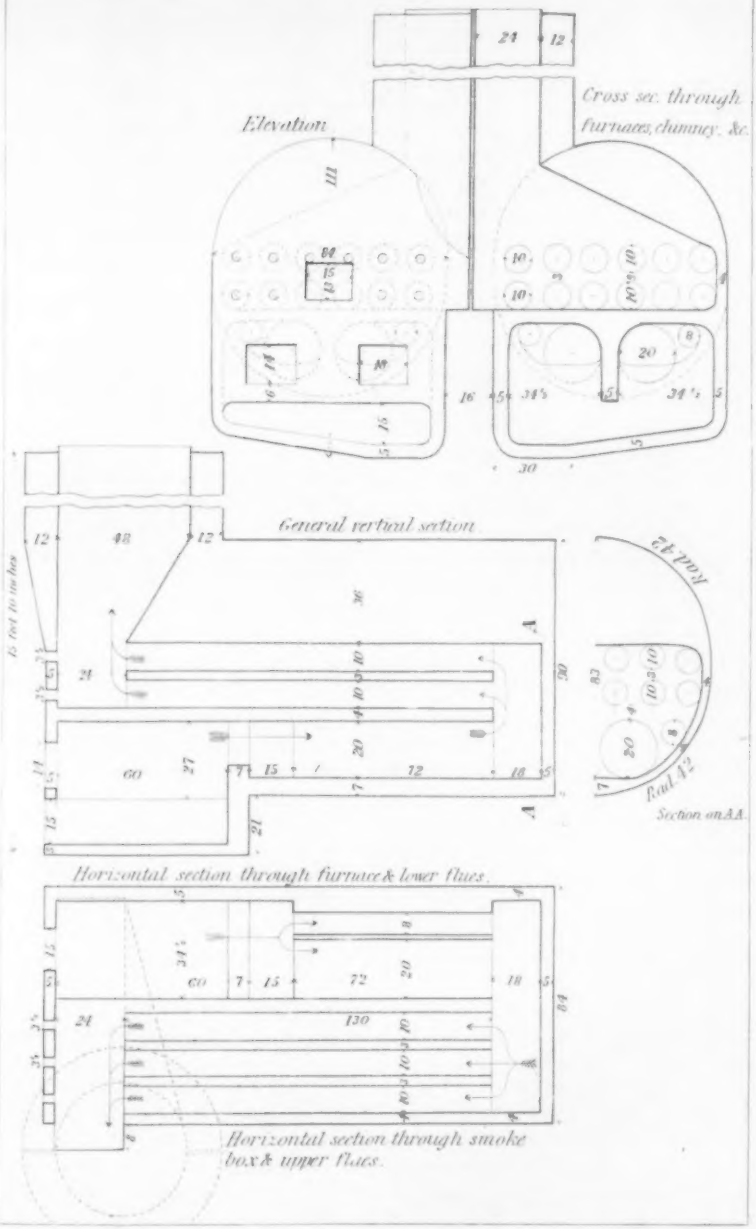
careened a little (7½° from the horizontal) by sail, one wheel is immersed to the axis. In such a case, the loss of effect by the oblique action of the paddles is vastly greater than its calculated per centage for the average immersion of both wheels; while the slip of the two wheels remains about the same, the increased resistance of the deeper water to the depressed wheel, about balancing its decreased resistance to the lifted wheel. The absolute amount of paddle surface was also considerably too small. For a vessel of the *Walker's* size, the paddles should have been 7 feet long, instead of 6 feet; and the wheel 19 feet diameter, instead of 16 feet, retaining nearly the same immersion as at present. The paddles on the present wheel are at the periphery about 4 feet 2 inches apart, which distance, for a sea-going vessel with so small a wheel, may be considered too great.

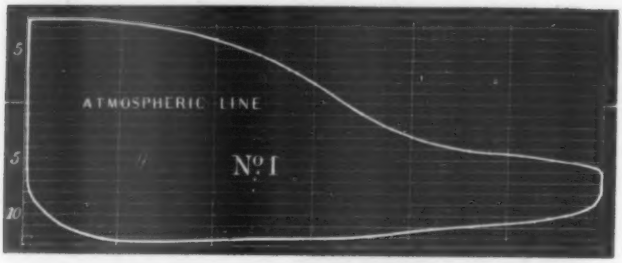
Of capacity of steam cylinders, there was a superabundance, but the boiler was too small to supply the intended quantity of steam, 15 pounds pressure per square inch above the atmosphere, cutting off at half stroke. Using the fan blast moderately, the boilers could with difficulty maintain an initial cylinder pressure of 6·3 pounds per square inch above atmosphere, burning 14·609 pounds of anthracite per square foot of grate per hour. The boilers were, however, well proportioned, giving the high evaporation of 8·008 pounds of steam per pound of coal, exclusive of the steam used for working the fan blast. This high evaporation may, I think, justly be attributed to the excellent proportions between the calorimeter (cross area of flues) and grate surface, and between the heating and grate surface. The least calorimeter was to the grate surface in the proportion of 1·000 to 5·681; while the heating was to the grate surface as 22·261 to 1·000. The disadvantage of a smoke pipe not high enough for good results with anthracite was compensated by a moderate fan blast. With a natural draft, the grates would consume 650 pounds of anthracite per hour, or 11·3 pounds per square foot. The advantages of a large calorimeter, are well illustrated in this boiler, proving beside, the high evaporative power of anthracite.

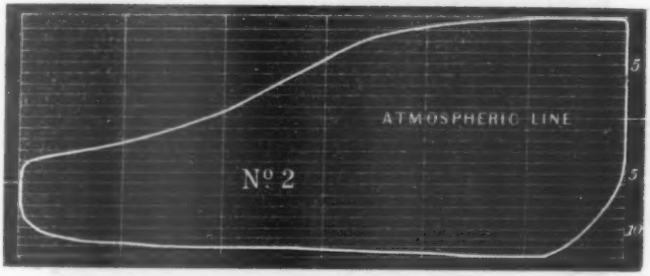
Indicator diagrams, Nos. 1 and 2, were taken nearly simultaneously from the front and back ends of the *starboard* cylinder. In No. 1, the mean effective pressure per square inch of piston was 12·83 pounds; in No. 2 it was 15·33 pounds; the boiler pressure being the same in both, viz: 10 pounds per square inch above the atmosphere; double strokes of piston, 22½ per minute.

Indicator diagrams, Nos. 3 and 4, were taken immediately after Nos. 1 and 2, from the front and back ends of the *port* cylinder. In No. 3 the mean effective pressure per square inch of piston was 10·17 pounds; the boiler pressure being 11 pounds per square inch above atmosphere; double strokes of piston, 23 per minute. In No. 4, the mean effective pressure per square inch of piston was 12·67 pounds, the boiler pressure being 9 pounds per square inch above atmosphere; double strokes of piston, 22 per minute. In all four diagrams, the vacuum per gauge in condenser was 27 inches of mercury, and the throttle one-third open; steam being cut off at half stroke. These diagrams show in a very marked manner, the effect of throttling. They also show that the exhaust valve closed when the piston had yet about one foot of its stroke to perform, *cushioning* the steam through that distance, and that the steam valve had no *lead*.

Boilers of the U.S. Steamer 'Walker'


Elevation
Cross sec. through furnaces, chimney, &c.
General vertical section
Rad. 42
Rad. 42
Section on A.A.
Horizontal section through furnace & lower flues.
Horizontal section through smoke box & upper flues.


5
ATMOSPHERIC LINE
5
Nº 1
10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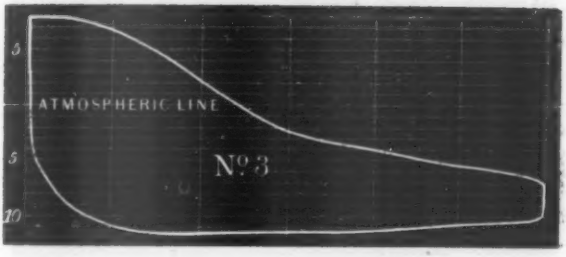
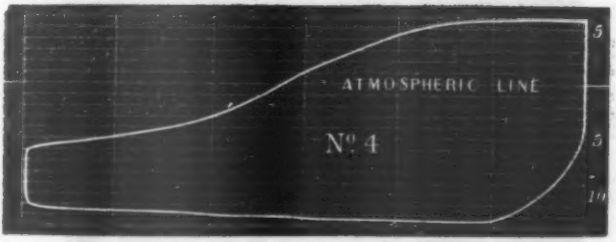
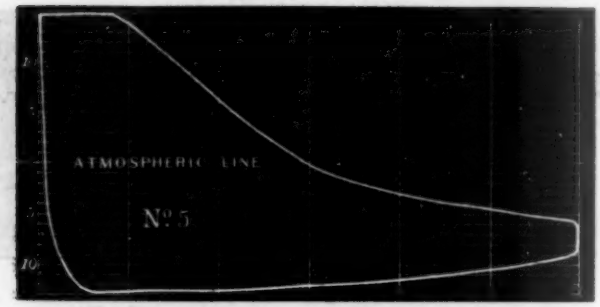
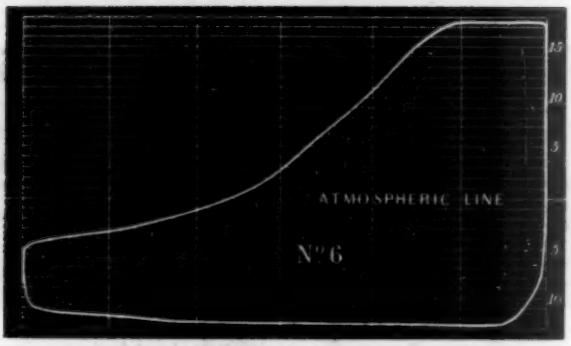
ATMOSPHERIC LINE
Nº 2
5


5
ATMOSPHERIC LINE
5
Nº 3
10


5
ATMOSPHERIC LINE
Nº 4
5
10


ATMOSPHERIC LINE
No 5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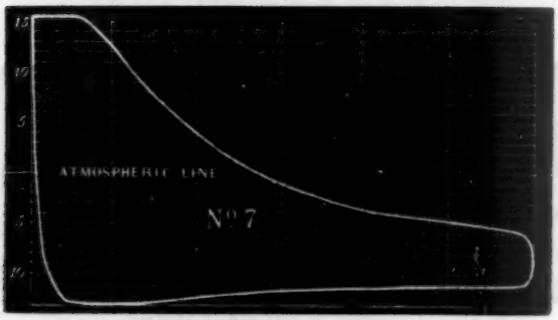
No 6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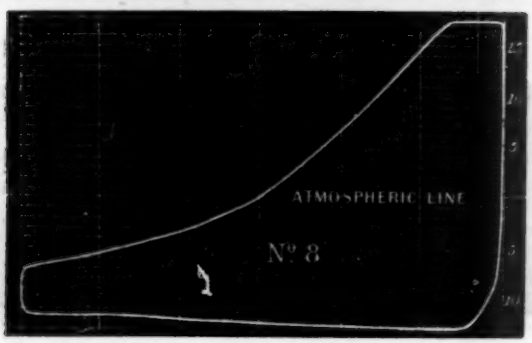
No 7


ATMOSPHERIC LINE
No 8

This manner of using steam proving unsatisfactory, the cylinders were altered as shown in indicator diagrams, Nos. 5, 6, 7, and 8. Nos. 5 and 6 were taken in succession from the front and back ends of the *starboard* cylinder; the steam pressure in boiler per square inch above atmosphere was respectively 15 and 18 pounds; double strokes of piston, 21 per minute. In No. 5, the mean effective pressure per square inch of piston was 14 pounds; in No. 6, 17·33 pounds; the steam in starboard cylinder was cut off at one-sixth the stroke from the commencement.

Nos. 7 and 8 were taken immediately after Nos. 5 and 6, from the front and back ends of the *port* cylinder; the steam pressure in boiler per square inch above atmosphere was respectively 16 and 17 pounds; double strokes of piston, 21 per minute. In No. 7 the mean effective pressure per square inch of piston was 13.33 pounds; in No. 8, 14·83 pounds; the steam in port cylinder was cut off at one-ninth the stroke from the commencement. In all of these diagrams the vacuum in condenser per gauge was 28 inches of mercury; throttle wide open.

I have no account of the fuel now used, but am informed that no difficulty is found in keeping steam; the corners of the diagrams are also much squarer than before, and the expansion curve shows the cylinder valves, which were of the "balance puppet" kind, to have been tight.

For the Journal of the Franklin Institute.

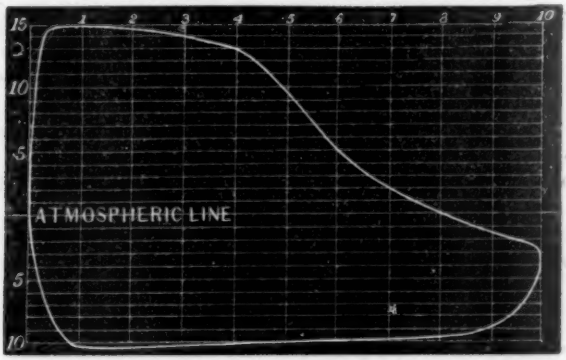
Performance of the U. S. Mail Steamer Arctic, on her Eighth Voyage from New York to Liverpool. By B. F. Isherwood, Chief Eng. U. S. Navy.

Day.	Date. 1852.	Average steam pressure in boiler. Pounds per sq. in.	Average revolutions per minute.	Total revolutions made per day.	Time h. m.	Anthracite coal. Tons burn'd per day.	Geographical miles ran per day.
1st	Feb. 8th.	17·0	14·5	20,550	23 45	85	300
2d	" 9th.	16·7	14·3	20,167	23 30	75	310
3d	" 10th.	17·5	15·3	21,704	23 34	80	325
4th	" 11th.	17·5	15·8	22,419	23 30	88	331
5th	" 12th.	17·0	15·7	22,254	23 25	89	336
6th	" 13th.	16·1	15·3	21,497	23 31	89	234
7th	" 14th.	17·0	16·4	23,104	23 25	92	316
8th	" 15th.	17·0	16·7	23,440	23 23	90	307
9th	" 16th.	16·7	16·5	23,237	23 22	91	301
10th	" 17th.	16·5	17·5	22,594	21 25	87	295
	Totals,			220,966	d. h. m. 9 16 41	866	3055
	Means,	16·9	15·827			8337·3 lbs. per hour.	13·13 pr h'r.

Indicator Diagram.—The accompanying indicator diagram shows the mean performance. When taken, steam pressure in boiler above atmos-

phere per square inch, 17 pounds; double strokes of piston per minute, 16; mean effective pressure on piston throughout the stroke, 16·9 pounds; throttle partly closed; calculating the horse power developed by the engine for this pressure and for 15·827 double strokes of piston per minute, we have, area of both pistons, 14176·46 square inches; stroke of piston, 10 feet; mean effective pressure per square inch of pistons, 16·9 pounds; speed of piston per minute, 316·54 feet.

$$\frac{14176{\cdot}46\times16{\cdot}9\times316{\cdot}54}{33000}=2298{\cdot}1 \text{ horse power.}$$



Evaporation by the Boilers.—The mean initial steam pressure in the boilers may be taken at 14·3 pounds per square inch above atmosphere, cut off at 4½ feet from commencement of stroke of piston. Space displacement of both pistons filled per stroke with steam, 443·016 cubic feet, to which add space comprised between cut off valve and piston at one end of cylinder, (for both cylinders,) 25 cubic feet, making a total bulk of 468·016 cubic feet of steam of the total pressure of 29 pounds per square inch, used per stroke of piston, which per hour would become (468·016×15·827×2×60) 888874·708.

The loss by *blowing off* at $\frac{2}{32}$, will be as follows: neglecting small corrections, total heat of steam, 1202° F.; temperature of feed water, 100°F.; temperature of steam of 29 pounds total pressure, 249·6°; then, 1202° —100° = 1102°; and, 249°·6—100 = 149·6°. Sum of the caloric utilized in steam and lost in *blowing off*, (1102°+149°·6)1251°·6, of which 1102° is 88 per cent. and $\frac{888874{\cdot}708\times100}{88}=1010084{\cdot}9$ total cubic feet of steam of 29 pounds total pressure generated per hour. The relative volumes of this steam and the water from which it is generated, is 911· and 1, and $\frac{1010084{\cdot}9}{911}=1108{\cdot}765$ cubic feet of sea water evaporated per hour, which at 64·3 pounds per cubic foot, would amount to 71293·59 pounds of water evaporated per hour by 8337·3 pounds of anthracite, or 8·55 pounds of water per pound of coal.

This is perhaps a higher result than has ever before been attained by a marine boiler making a long trip, and fired and cleaned in the ordinary manner by ordinary firemen. It will be observed that the results obtained

under the above practical conditions, are very different from what would be given by a more experimental trial of a few hours on shore, with a small quantity of fuel skilfully burned, and all avenues of losses carefully guarded. It must also be considered that these boilers have been in use for some time, and are probably considerably encrusted with scale.

The features of these boilers are, 1st, The heating surface is nearly all vertical surface.

2d, The proportion of calorimeter or draft area to the grate surface is very large at first, and diminishes to nearly one half in the chimney, being at front of tubes, 1·000 to 5·205; at back of tubes, 1·000 to 7·840; in chimney, 1·000 to 10·000.

3d, The proportion of heating to grate surface is very large, being 33½ to 1.

4th, The hot gases are kept by means of a hanging bridge in contact with the heating surface, until their temperature is properly reduced.

5th, A very great height of chimney, being 75 feet above grates, giving a good draft even with the greatly diminished chimney calorimeters; the rapidity of the combustion is not remarkable as either fast or slow, being at the rate of 13·13 pounds of coal per square foot of grate per hour.

6th, A double tier of furnaces, one furnace in the upper and one in the lower tier, mingle their hot gases at the same bridge. By alternate firing below and above, the temperature of the mingled gases is always kept sufficiently high for combustion, while practically, no inconvenience is found in firing furnaces so arranged.

Slip of the Paddle Wheel.—The circumference of the centre of effort of the paddles is 107·3 feet. The mean slip was, therefore,

107·3×15·827×60=101894·226 ft.=sp. of cen. effort of paddles p. h.
13·13×6140 = 80618·200 ft.=speed of vessel per hour.

21276·026 ft.=slip per hour, or 20·88 per cent.

For the Journal of the Franklin Institute.

Propeller Steamers between Boston and Halifax.

The Boston merchants, after chaining their tri-mount City to the surrounding States as well as the Canadas, by the aid of their seven magnificent railroads, have concluded to extend the sphere of their mercantile enterprise, by launching into a new element, in the establishment of a line of propeller steamers, to ply between Boston and Halifax; and to that end, Messrs. Clark & Jones have contracted for a propeller as the pioneer, of the dimensions herein given.

The trade between Boston and Halifax has heretofore been carried on by a line of sailing vessels, belonging to the same gentlemen, except what may have been done by the English Mail Steamers.

The manifest advantages of propellers over sailing vessels is so plain, from the fact, that the trips of the latter must necessarily be without regularity, while those of the former, under all ordinary circumstances, can be be depended on, that the surprise is, that a line of this description has not been put in operation before this. Many passengers from Halifax, as

well as other parts of Nova Scotia, coming to Boston, have heretofore crossed to St. Johns, N. B., and then taken steamers to Boston; a great portion of this travel will undoubtedly come by this new line. A fair proportion of the travel also between the Canadas and Nova Scotia will also, doubtless, prefer the route to Boston by railroad, and thence by this line to Halifax. This accommodation of passenger traffic, and a continually increasing trade with the Provinces, furnish good ground for the belief, that the enterprise will prove successful. One trip a week is anticipated.

The following are the dimensions of the hull, engines, &c.:

HULL.

Length on deck,	171 feet.
" between perpendiculars,	168 "
Breadth of beam,	28 "
Depth of hold,	18 " 6 inches.
Tonnage,	700 tons.

Three-masted schooner rigged, with foresail and foretopsail. Hollow lines, with an exceeding fine entrance.

Builder—Mr. J. D. Curtis, of Medford, Massachusetts.

DIMENSIONS OF ENGINES, &c.

Two cylinders, inverted.

Diameter of cylinders,	44 inches.
Length of stroke,	33 "
Diameter of air pumps,	
Length of stroke,	18 "
Slide Valves,	
Diameter of shaft in journals,	10 "
Diameter of propeller,	8 feet 4 "

Air pumps worked by beams from cross-head. S.

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*Baillie's Volute Springs.**

The only springs shown in the Great Exhibition, which were lucky enough to gain a prize, were Baillie's volutes; and it is not perhaps too much to add, that their simplicity and excellence fully entitle them to this distinguishing honor. The material of which they are made is flat steel with parallel edges, but tapering in thickness from one end to the other. Such pieces of metal are wound spirally into a cone, so as to sustain pressure and deflexion in the direction of the breadth of the metal. In bringing the invention before the readers of this *Journal*, we have selected as illustrations two examples of the springs as applied to railway purposes.

Fig. 1 is a longitudinal section of a double-spring railway passenger carriage-buffer. The outer cylinder, A, bolted to the front buffer beam, has within it the two volutes, B C, set with their apices towards each other, upon a guide-spindle fastened to the cylinder bottom, this spindle having upon it a bearing disk to receive the pressure from the two springs, when forced towards each other. The short sliding cylinder, D, carrying the buffer disk on its outer end, is fitted to slide within the open end of the spring cylinder, A, and encircles one of the springs, B, a diaphragm being cast across the cylinder, D, to communicate the external pressure to the base of the spring, and to act as a further guide, by passing the

* From the London Practical Mechanic's Journal, December, 1851.

spring-guide spindle through its centre. It thus forms a most compact buffer, one or more volutes being enclosed in the cylinder according to the extent of range required. The springs may also be fitted up by simply stringing two or more springs on the rods beneath the carriage body, and as the volutes do not interfere with the timbers of the trussed framing, a more simple and rigid structure is attainable with a smaller amount of woodwork.

For engines and goods wagons a single spring only may be used, the most economical fitting being simply to fix them on the buffer-rod beyond the end framing, and if the springs need any protection, the timbers may be conveniently contrived with a hollow to receive them.

Fig. 1.—1-12th.

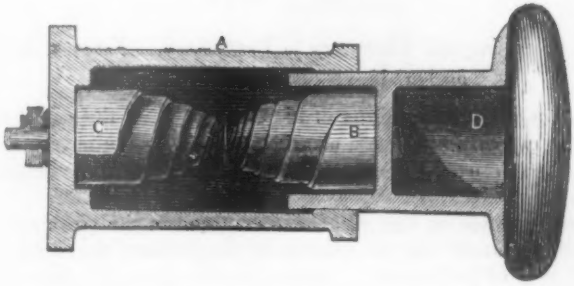

Fig. 2.—1-24th.

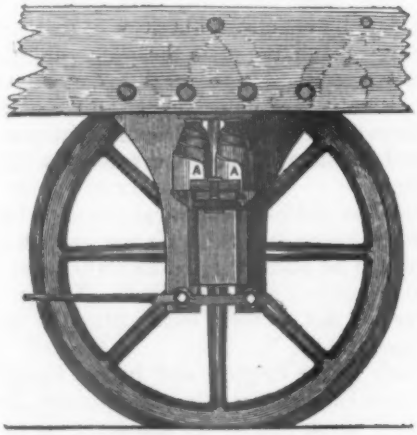

Fig. 3.—1-32d.

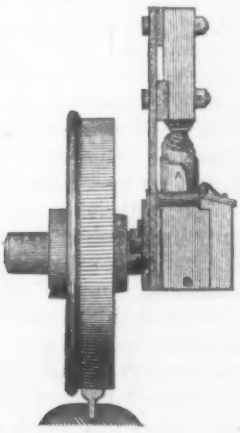

Fig. 2 exhibits a side elevation of a portion of a wagon frame, with its wheel and axle-box, to show the application of the volutes as bearing springs. Fig. 3 is an end elevation of the same, drawn to a slightly smaller scale. The top of the axle-box has a short cross-bar, which answers to receive the bases of a pair of springs, A, set one on each side the line of the axle's centre, on guide-spindles—the apices, of course, abutting against the lower side of the frame. One spring in the centre may be used instead of two, but the duplex arrangement is much more efficient.

As drawing springs, they are applied by passing through them a bolt with adjustable nuts, to convey the pressure to the apex of the volute. If placed at or near the centre of the carriage, they will act both ways, by using a short length of tube with a slot in the draw-bar. The latter can in this way lengthen itself, rendering great assistance to the engine in getting under way with a heavy train. It is claimed for this form of spring, that it is capable of sustaining equal loads with one-third the weight of steel necessary in the common spring. Although thus light, the peculiarity of action in applying the pressure edgewise to the coils, renders them remarkably free from liability to fracture, whilst, whatever amount of force is sustained by them, the coils are always brought up to a firm bearing at the end of their traverse.

Application of Organic Chemistry to Perfumery. From a Letter written by DR. HOFMANN *to* PROF. LIEBIG.*

The beautiful investigations of M. Cahours upon the oil of *Gualtheria procumbens*, which have made us acquainted with the nature of this compound, so much used in perfumery, appears not to have been lost sight of in the arts.

The arrangement of the oil of winter-green in the group of the compound ethers could not do otherwise than direct the attention of the manufacturers of perfumery to this extensive class of bodies, the number of which is still further daily increased by the active energy devoted to the field of organic chemistry. The remarkable fruity odor of many of these ethers had not been overlooked by chemists; but it was reserved for practical men to make the selection and ascertain the proportions in which certain of these compounds resembled in so great a degree the aroma of particular fruits, that we almost feel ourselves led to the idea, that these very compounds are the cause of the odor of the fruits in question, and that they would be found in them, if the processes were followed on a sufficiently large scale.

The artificial production of aromatic oils for commercial purposes has only been carried on for the last few years; but although the process of fabrication is so new, yet it appears to be already in the hands of several distillers, some of whom make tolerably large quantities. The jury were enabled to satisfy themselves of this, in their examination of the products belonging to this department in the Exhibition. We found in our surveys at the Exhibition, both in the English and in the foreign divisions, a copious selection of these chemical articles of perfumery, the applicability of which was moreover illustrated by the simultaneous exposition of the confectionary flavored with them.

Unfortunately, most of these oils were only sent in small quantities, so that the specimens which I was enabled to obtain, in few cases only allowed of accurate examination.

The compound most frequently exhibited was a liquid labelled "*pear oil*," which on examination was shown to be an alcoholic solution of pure *acetate of amylic oxide*. As I had not enough of the compound to allow of its sufficient purification for ultimate analysis, I decomposed it with

*From the Chemical Gazette, London, March 1, 1851.

potash, when free fusel oil separated, and the acetic acid was determined in the form of the silver salt. The acetate of silver gave per cent.

Theory.	Experiment.
64·68	64·55

The acetate of amylic oxide, when obtained by the ordinary process, (one part of sulphuric acid, one part of fusel oil, and two parts of acetate of potash,) evolved a remarkably fruity odor; but the agreeable odor of the Jargonelle pear was not distinct until it was diluted with 6 vols. of alcohol. On close inquiry of the exhibitors, I ascertained that tolerably large quantities of this oil (in one case 15–20 lbs. weekly) are manufactured. It is principally used for flavoring pear drops, which are much admired in England, and which consist almost entirely of barley sugar.

Next came the *apple oil*. As the examination shows, it is nothing more than valerianate of amylic oxide, and every one is at once reminded of the insupportable odor of rotten apples, which fills the laboratory, in making valerianic acid. When the crude distillate of this operation is treated with dilute alkali, the valerianic acid is separated, and an ether is obtained, the solution of which in about 5 or 6 vols. of alcohol possesses a most agreeable aroma of apples.

The essence in greatest quantity was the *pine apple oil*, which, as you are aware, is only butyrate of oxide of æthyle. This compound, also, like the two above, does not evolve the agreeable odor until diluted with a large amount of alcohol. Butyric ether, which in Germany is frequently added to the inferior kinds of rum, is principally used here for flavoring a kind of lemonade (pine apple ale). For this purpose it is however seldom prepared from pure butyric acid, but generally by merely saponifying the butter, and distilling the soap with concentrated surphuric acid and alcohol. The liquid thus obtained of course contains other ethers besides butyric ether, but it may be used in this state for flavoring. The specimen which I analyzed appeared however to be the pure ether prepared from butyric acid. When decomposed by potash, and converted into a silver salt, it yielded—

Experiment.	Theory.
55·33	53·38 per cent. of silver.

The so called *cognac oil* and *grape oil* were sent both by English, as also French and German exhibitors. They appear to be used pretty commonly for imparting the favorite cognac odor to low brandies. Unfortunately, the specimens exhibited were too small in quantity to allow of my instituting an accurate examination of these oils. The cognac oil especially was in very small quantity; on the addition of water to the whole of the sample, a few drops only separated, and these consisted of a mixture. The grape oil is also an amyle compound, dissolved in much alcohol; for when treated with concentrated sulphuric acid, the oil, freed from alcohol by washing with water, yielded sulphate of amylic oxide, which was identified by the analysis of the barytic salt. It yielded 45·82 per cent. of sulphate of baryta.

The crystallized amylo-sulphate of baryta with two equivs. of water, analyzed by Cahours, and again recently by Kekulé, contains 45·95 per cent. of sulphate of baryta. It is certainly remarkable, that we see here

a body, which on account of its insupportable odor is separated from brandy with the greatest care, again applied in an altered form to flavor this beverage.

I must also allude to the *artificial oil of bitter almonds*. When Mitscherlich, in 1834, discovered nitro-benzole, he little thought, after twenty years, to find this body in an industrial exhibition. He certainly, at that time, pointed out the remarkable resemblance which the odor of nitro-benzole had to that of oil of bitter almonds; but the only sources for obtaining benzole at that time, viz: the oil of compressed gas and the distillation of benzoic acid, were much too expensive, and put an end to the idea of substituting the use of nitro-benzole for oil of bitter almonds. However, as you recollect, by means of the well known aniline reaction, I showed with the utmost certainty the presence of benzole in the common light oils of coal tar, which had frequently been previously suspected; and in 1849, C. B. Mansfield showed, by a careful investigation, that benzole may be procured easily, and in large quantity, from oil of coal tar. In his memoir, which contains many valuable details upon the practical applications of benzole, the possibility that the fragrant nitro-benzole may be obtained in larger quantities is alluded to. As the Exhibition shows, this remark has not been lost sight of in the arts. Among the articles of French perfumery, with the title of *artificial oil of bitter almonds*, and the fanciful name of *essence of Mirbane*, there were several specimens of oils, which on accurate examination proved to consist of more or less pure nitro-benzole. I was not enabled to ascertain accurately the extent of this fabrication; but it appears to me by no means inconsiderable. Here, in London especially, tolerable quantities of this artificial oil of bitter almonds are prepared. The very simple apparatus used is that proposed by Mr. Mansfield. It consists of a large glass worm, the upper end of which branches into two tubes, which are provided with funnels. A stream of concentrated nitric acid flows slowly through one of these funnels, whilst the other is for the benzole (which for this purpose need not be absolutely pure.) At the point at which the tubes of the funnels are united, the two bodies come in contact; the chemical compound formed becomes sufficiently cooled in passing through the worm, and only requires to be washed with water, and finally with some weak solution of carbonate of soda, to be ready for use. Although the nitro-benzole closely resembles oil of bitter almonds in physical properties, it possesses however a somewhat different odor, readily recognised by a practised hand. However, it answers well for scenting soap, and would be extensively applicable for confectionary and for culinary purposes. For the latter purpose it has the special advantage over oil of bitter almonds, that it contains no prussic acid.

Besides these, several other similar products were exhibited, but most of them were of too compound a nature, and in too small a quantity, to allow of their composition being accurately determined. In the case of many of these essences, their resemblance to the aromas specified was very doubtful.

The application of organic chemistry to perfumery is still in its infancy; and we may expect that a careful survey of those ethers and etherial compounds with which we are at present acquainted, and those which

are daily being discovered, will lead to further results. The interesting caprylic ethers, which M. Bouis has lately discovered, are remarkable from their extremely aromatic odor, (thus the acetate of caprylic oxide possesses an odor as strong as it is agreeable,) and promise, if they can be obtained in larger quantities, to yield new materials for perfumery.—*Ann. der Chem. und Pharm.*, *vol.* LXXXI, *p.* 87.

On the Expansion of some Solid Bodies by Heat. By HERMANN KOPP.*

The method of experiment adopted by Prof. Kopp in his laborious and valuable investigation is to ascertain the specific gravities of a body when immersed in fluids of various temperatures, and thence, by means of the known expansion of the fluid, to determine the cubic expansion of the body. A flask was taken furnished with a carefully ground glass stopper; and the first point to be ascertained was, "what weight of water, freed from air, and at different temperatures, was the flask able to contain?" For low temperatures, the flask and its contained water were placed in a large vessel filled with the same fluid, the temperature of which was shown by two thermometers immersed in it. When it was certain that the flask had assumed the temperature of the surrounding water, the stopper (which was preserved at the same temperature,) was set on, the flask dried, and then carefully weighed. For temperatures of 40° or 50° C., the flask was immersed in a large beaker filled with water, which again was immersed in a second larger beaker, also full of water; the latter was heated, and after some time the water surrounding the flask acquired a uniform temperature of the required height; the glass stopper, which up to this time had been preserved in water of the same temperature, was now set on, the flask removed, dried, and weighed as before. When the quantity of boiling water held by the flask was to be ascertained, the latter was properly fixed in the neck of a large bolt-head, in which a quantity of water was kept violently boiling. The flask was here surrounded by steam, and precautions were taken to prevent any inconvenient loss of heat by radiation or by contact with the surrounding air.

Having ascertained the amount of water embraced by the flask at numerous temperatures, a proceeding exactly similar was followed to ascertain the specific gravity of the substance. The flask with the substance alone was first weighed; the flask was then filled with water, the air completely expelled by boiling, and then the weight of the known quantity of solid substance, plus the weight of the water necessary to fill the flask at various temperatures, was ascertained.

Suppose the weight of the flask of water at the temperature t^0 to be W, the weight of the solid substance to be examined to be P, and the weight of the water and substance which together filled the flask at t^0 to be S, then we have

$$\frac{P}{W-(S-P)} = D_t$$

where D_t expresses the specific gravity of the substance referred to water of the temperature t^0 as unit. Further, is $\frac{D_t}{V_t} = D_0 =$ the specific gravity

* From the Lond., Edinb., and Dublin Philosoph. Magazine, April, 1852.

of the solid substance at t^0 referred to water at 0^0 as unit, where V_t expresses the volume which one volume of water at 0^0 assumes on being heated to t^0.

Supposing that for two temperatures t and t', the former of which is lower than the latter, the specific gravities D_0 and D_0' respectively be found, then is the cubic expansion of the body

$$= \frac{1}{t'-t} \cdot \left(\frac{D_0}{D_0'} - 1 \right)$$

The expansion of water by heat was made the subject of special inquiry, and numerous substances were examined whose linear expansion had been determined by other methods and other men; the agreement between M. Kopp's results and those already determined furnishes a proof that the method pursued and precautions taken may be relied on.

We here transcribe a tabular statement of M. Kopp's results, premising that each is the mean of several experiments:—

Substance,	Formula.	Cubic expansion for 1°.	Determined by means of
Copper,	Cu	0·000051	Water.
Lead,	Pb	0·000089	"
Tin,	Sn	0·000069	"
Iron,	Fe	0·000037	Mercury.
Zinc,	Zn	0·000089	Water.
Cadmium,	Cd	0·000094	"
Bismuth,	Bi	0·000040	"
Antimony,	Sb	0·000033	"
Sulphur,	S	0·000183	"
Galena,	PbS	0·000068	"
Zinc blende,	ZnS	0·000036	"
Iron pyrites,	FeS^2	0·000034	"
Rutile,	TiO^2	0·000032	"
Oxide of tin,	SnO^2	0·000016	"
Oxide of iron,	Fe^2O^3	0·000040	"
Magnetic ore,	Fe^3O^4	0·000029	"
Fluor spar,	CaFl	0·000062	"
Arragonite,	CaO, CO^2	0·000065	"
Calcareous spar,	CaO, CO^2	0·000018	"
Bitter spar,	$CaO, CO^2 + MgO, CO^2$	0·000035	"
Carbonate of iron,	$Fe\,(Mn, Mg)\,O, CO^2$	0·000035	"
Heavy spar,	BaO, SO^3	0·000058	"
Cœlestine,	SrO, SO^3	0·000061	"
Quartz,	SiO^3	0·000042	"
		0·000039	Mercury.
Orthoklas,	$KO, SiO^3 + Al^2O^3, 3SiO^3$	0·000026	Water.
		0·000017	Mercury.
Glass, soft soda glass,		0·000026	Water.
Glass, soft soda glass, another kind,		0·000024	Mercury.
Glass, hard potash glass,		0·000021	Mercury.

Taking every possibility of error into account, M. Kopp considers that we may infer with certainty from the preceding numbers, that the expansion of solid substances is by no means determined by their chemical nature. The difference between the coefficients of expansion for arragonite and calcareous spar is so great as to destroy all hope of establishing any relation of the kind. Neither does the expansion appear to depend altogether on the arrangement of the atoms; for although bitter

spar and carbonate of iron agree, and heavy spar differs but little from cœlestine, in the cases of carbonate of iron and carbonate of lime, and of rutile and oxide of tin, no such agreement exists. The table further shows that there are many non-metallic substances which expand as much under the action of heat as the metals themselves.—*Ann. der Chem. und Pharm.*, *Vol.* LXXXI, *No.* 1, *p.* 1–67.

Description of a New Method of Preparing Negative Photographic Paper.

By M. GUSTAVE LEGRAY.*

Persons who are engaged in the process of photography on paper, are well aware of the difficulty of obtaining paper of a good quality, and suitably adapted to receive uniformly the requisite chemical preparations.

After having made a great number of trials, I have succeeded in meeting this difficulty by the use of a size adapted, I may say, to any kind of paper.

Paper thus prepared so much facilitates the photographic process, and helps to assure a satisfactory result, that I make no doubt it will be generally adopted.

The substance used for this size is virgin wax, which is kept at a temperature of 100° centigrade, in a large flat vessel, and the paper is immersed therein until completely saturated with the wax. The sheet of paper is then withdrawn, and laid between several pieces of blotting paper, over which a moderately heated iron is passed, which causes the blotting paper to absorb the superfluous wax. If the paper is properly prepared, there will be no gloss whatever on its surface, and it will be perfectly transparent.

The waxed paper is then immersed in a warm solution, composed as follows:

1000	parts	of rice water.
40	"	sugar of milk.
15	"	iodide of potassium.
0·80	"	cyanide of potassium.
0·50	"	fluoride of potassium.

The sheet of paper should be laid in this solution for half an hour, and it may then be withdrawn, and hung up to dry.

The paper is then immersed in a clear solution of aceto-nitrate of silver, which is thus formed:

300	parts	distilled water.
20	"	azotate of silver.
24	"	crystallizable acetic acid.
5	"	animal charcoal.

The animal charcoal serves to render the paper more susceptible to receive impressions, and decolorizes the solutions when they have been previously used. The paper should remain three minutes in this solution, and in order to insure contact with the liquid, the two sides of the sheet should be rubbed over with a brush. The paper is then washed several times with distilled water, and well dried between pieces of blotting paper. Paper thus prepared may be taken immediately into the dark chamber, and it is not necessary to subject the image to the action of

* From the London Mechanics' Magazine, for January, 1852.

gallic acid on its removal from the camera; this may be deferred till the evening, or even the next day, or the day following.

The paper may be kept in a dark place for more than a fortnight without undergoing any alteration, and in this respect offers greater advantages than any of the photographic papers hitherto known. The solution of gallic acid is composed of 1 part of gallic acid, half part (0·5) of azotate of silver, and 200 parts of distilled water. The image is fixed as usual by hydro-sulphite of soda.

I have submitted to the Academy a series of specimens obtained by this process. It is so easily put in practice that, during a mission which I have just fulfilled for the Commission of Historical Monuments, I have often taken twenty-five or thirty photographs a day.

Improvements in the Manufacture of Glass, Porcelain, Earthenware, China, and Artificial Stone.—Patented October 2, 1851, by W. Hodge, of Cornwall.*

For the purposes above specified, hornstone porphyry is adopted by the patentee as a material which has not been hitherto used.

Claim.—The application of this material, called elvan, to the manufacture of glass, porcelain, earthenware, china, and artificial stone.

For the manufacture of glass, it is powdered, washed, and mixed with other pulverized materials in the melting pot.

For the manufacture of porcelain, &c., it may be used alone or in combination with other materials. It is powdered, brought to a plastic state, moulded, dried, and fired in the usual way. It can likewise be employed for making glazes.

For the manufacture of artificial stone, it is used alone or combined with broken stone, and reduced to a plastic condition, moulded into blocks, dried, and fired in the usual manner.

Experimental Researches in Electricity. Twenty-ninth Series. By Michael Faraday, Esq., D. C. L., F. R. S., &c.†

In the present series of researches the author endeavors in the first place to establish the principles he announced in the last, with regard to the definite character of the lines of magnetic force, by results obtained experimentally with the magnetic force of the earth. For this purpose he reverts to the thick wire galvanometer before described, and points out the precautions respecting the cleanliness of the coils, the thickness and shortness of the conductors, the perfect contacts, effected either by soldering or cups of mercury; and marks the value of double observations, i. e. observations afforded on both sides of zero. The nature of the impulse on the needles is pointed out; being not that of a constant current for a limited or unlimited time, but of a given amount of electricity exerted, either regularly or irregularly, within a short period; and it is shown

* From the London Civil Engineer and Architect's Journal, May, 1852.

† From the London, Edinburgh, and Dublin Philosophical Magazine, April, 1852.

experimentally that such impulses produce equal results of deflexion, and also that when two or more such impulses are given within a limited time, the whole arc of swing is nearly proportional to their number; so that the amount of deflexion, *within certain limits*, indicates directly, nearly the proportion of electricity which has passed as a current through the instrument.

If a wire be formed into a square of 12 inches in the side, and then fixed on an axis passing across the middle parallel to two of its sides, and if, when that axis is perpendicular to the line of dip, the whole is rotated, then two of the sides of the rectangle will, in one revolution, twice intersect the lines of force of the earth passing across or through one square foot of area. The currents then tending to move in the upper and lower parts of the rectangle, will conjoin to urge one current through the wire; and if this wire be cut at one place close to the axis, and be there connected with a commutator of simple construction, which is described in the paper, the currents round the rectangle may be conveyed away to the galvanometer, and there measured. Such a rectangle, constructed of copper wire one-twentieth of an inch in thickness, gave a certain arc of swing for one revolution. If five or ten revolutions were made, within the time of vibrating of the needle, nearly five or ten times this amount of deflexion was produced; the mean result, in the present case, was 2°·624 per revolution. When the same length of the same wire was arranged in oblong or oblate rectangles, so as to diminish the inclosed area in different directions as regarded the axis of revolution, still the deflexion was in every case proportional to the areas included; showing that the effect produced was proportional to the number of lines of force intersected by the moving wire. The same result was obtained when two squares having areas in the proportion of 1 to 9, were employed.

When squares of the same area were formed of copper wire of different thicknesses, then the effects of obstruction in the conducting part of the system were brought out and measured. Thus, with wires which were 0·05, 0·1, and 0·2 of an inch in diameter, and therefore in mass as 1, 4, and 16, the deflexions were 1, 2·78, and 3·45; a result almost identical with that obtained for the same wires by the use of loops and a local magnet in the former researches. When two equal rectangles were compared, one containing a single circuit of 4 feet of wire 0·1 in thickness, and the other four circuits of 16 feet of wire 0·05 in thickness, then the first was found to evolve the largest quantity of electricity; but the second, electricity of the highest tension, by the same amount of motion: the accordance of these results with the principles advanced is pointed out. The author then refers to the use of wire rings of one or many convolutions, and indicates cases in which they may supply valuable means of experimental inquiry.

The relative amount and disposition of the forces of a magnet when it is alone, or associated with other magnets, forms the next point in the present paper; and a distinction is first taken between ordinary magnets, which are influenced much by other magnets, so that the amount of their external force varies greatly, and those which are very hard, where this influence is reduced to little or nothing. The power of a given magnet

was measured according to the method described in the last series, by a loop once passed over its pole. A given hard magnet placed in an invariable position, being thus estimated, was found to have a force equivalent to 16°·3 of deflexion. Another magnet, having a power of 25°·74, was then placed close to the first in different positions, with like or unlike poles near together, so as to tend sometimes to exalt its power and at other times to depress it; and the results observed. In the extremest favorable case, namely, when the two were conjoined as a horse-shoe magnet, the force of the first magnet was only raised 2°·45, which fell directly the dominant magnet wes removed; in the corresponding adverse case the depression was only 1°. A very hard magnet, made by Dr. Scoresby, of 6°·88 power, when under the influence of another of double its power, was not sensibly affected either way. When under the influence of one of six times its force, it could be affected to the extent of nearly 1°. Ordinary magnets could be affected to the extent of one-half of their power or more; and indeed in extreme cases can be altogether overruled and inverted.

From these results the author concludes, that, with perfect unchangeable magnets, the lines of force (as before defined) of different magnets in favorable positions, coalesce; that there is no increase of the total force by this coalescence; the sections between the associated poles giving the same sum of power as the sections of the lines of either magnet alone; that as the external amount of force of the magnet is not varied, neither is the internal amount at all changed; that the increase of power upon a magnetic needle, or a piece of soft iron, placed between two opposite favorable poles, is caused by concentration of the lines which before were diffused, and not by the addition of the power represented by the lines of force of one pole to that of the lines of force of the other. There is no more power represented by *all* the lines of force than before, and a line of force is not in itself more powerful because it coalesces with a line of force of another magnet. In this and in other respects, the analogy of the magnet with the voltaic pile is perfect.

The paper concludes with some practical remarks upon the delineation of the forms of the lines of force by iron filings, and by a description of the inflexion of the lines by hemispheres of hot and cold nickel; which the author considers as the corresponding case to the action of warm and cold oxygen in the atmosphere, as applied by him in the explication of some of the phenomena of atmospheric magnetism, and especially of the annual and daily variation.

Repair of a Vessel's Bottom while Afloat. By W. Moody, Foreman of Shipwrights.*

The *Geyser*, steam sloop, has been taken into dock, and her bottom examined, as it was greatly injured by the vessel striking on the rocks at Ile Grand, about 50 miles from Janeiro. Fifty-four feet in length, and several planks in breadth, had been stove in by the accident, but her commander, by adopting a plan suggested by Mr. Moody, foreman of

* From the London Civil Engineer and Architect's Journal, January, 1852.

shipwrights at Woolwich Dockward, the *Geyser* was repaired while afloat, and brought home safe to this country, although the injuries she sustained were within a short distance of the keel.

The following, which has been issued by the Admiralty, explains the mode of repairing the damage the *Geyser* sustained on a shore where she must otherwise have been left to her fate, as the tides only rise a few feet, and the great weight of her engines would have prevented her being drawn up on shore.

"In obedience to directions to report the manner in which I proceeded to replace a defective sheet of copper on the bow of her Majesty's ship *Hyacinth*, the same being five feet below the light water-line, I beg to state, that on considering what means could be adopted for so doing, short of heaving the vessel out, it occurred to me that the principle of coffer-dam might be applied to it. I accordingly caused a water-tight case of three sides and a bottom to be made, ascertained the curve on the bow on each side of this defective part, and cut the mouth or open side of the case to fit it; and having lined or dressed the curved edges with felt, saturated with tallow, and attached ballast to the bottom, the case was suspended by a tackle to the rough tree rail, and lowered until the top was within a few inches of the surface, opposite the defective part, over which it was hauled by means of two hawsers, one placed vertically from the rough tree rail under the keel to the opposite side, the other horizontally from the quarter round to the stern to the opposite side, and both set taut with tackles. By these means the case was made to fit close to the bottom, where it was further secured by a shore, reaching from the side of the ship to its outer edge, to prevent its rising. The suction hose of a fire engine was then placed in the case, and the water contained in it pumped out. When empty, two shipwrights descended, and removed the defective copper, replacing it with a new sheet. The operation from the time of suspending the case until completed, did not occupy more than twenty minutes.

"This principle could be applied to the repairs of many defects under water, such as the wing cocks of ships, or the pipes in the bottom of steam vessels."

On the Compounds of Cotton with the Alkalies. By Dr. J. H. GLADSTONE.*

The author first described the process of Mr. Mercer, by which the beautiful fabrics made known to the public through the Great Exhibition are produced. When cotton, or an article made of that material, is immersed in strong caustic soda in the cold, a certain combination is effected—which is again destroyed by pure water; but the "Mercerized" cotton thus produced is permanently contracted, and rendered more susceptible of dyes. This was illustrated by a number of specimens, much shrunk, so that they assumed an appearance of extraordinary fineness, others puckered in patterns by partial Mercerization, and others again printed with colors which surpassed in depth and brilliancy the colors

* From the London Atheneum, February, 1852.

produced by the same means on the calico in its original state. Dr. Gladstone proceeded to detail experiments by which he had succeeded in obtaining the compound of cotton and soda free from adhering alkali, through the agency of strong, sometimes absolute, alcohol. He found that the proportion of soda which combined with the lignine varied with the strength of the solution employed, but under no circumstances exceeded one atom. There was a varying amount of combined water. Some properties of this compound were discussed, and the author then proceeded to state his conviction, that there was no sufficient ground for viewing the "Mercerized" cotton as chemically different from the original lignine. It is identical in composition, and the change of properties may be accounted for by the change in its physical condition. When viewed under the microscope, the fibres in their ordinary condition appear as flattened twisted ribands; but the moment they are touched by the alkaline ley, they untwist themselves, contract in length, and swell out, assuming a rounded solid form; and this circular appearance they retain after the soda is removed by water. This not only explains the shrinking, but the cause of a larger quantity of dye being absorbed as the substance of the fibre itself is porous. Potash has a similar action to that of soda.

FRANKLIN INSTITUTE.

Proceedings of the Stated Monthly Meeting, June 17, 1852.

Edmund Draper, Esq., President, *Pro. Tem.*
John F. Frazer, Treasurer.
Isaac B. Garrigues, Recording Secretary.

The minutes of the last meeting were read and approved.

Donations were received from The Royal Astronomical Society, London; Henry Gassett, Esq., Boston, Massachusetts, and Messrs. P. A. Brown, Dr. L. Turnbull, Percival Roberts, Geo. M. Conarroe, and Dr. Charles M. Wetherill, Philadelphia.

The Periodicals received in exchange for the Journal of the Institute were laid on the table.

The Treasurer read his statement of the receipts and payments for the month of May.

The Board of Managers and Standing Committees reported their minutes.

New candidate for membership in the Institute (1) was proposed, and the candidates (6) proposed at the last meeting were duly elected.

Mr. Geo. W. Smith reminded the meeting that on February 20, 1851, he had presented a list of the number of miles of railroads at that time completed in the United States, and an estimate of the number of miles that would be completed during the present year. Nearly two years having elapsed since the presentation of that estimate, he now had it in his power, from the reception of information from the whole of the United States, to test the accuracy of the predictions. The amount completed and to be completed the present year, inclusive, may be stated at 13,200 miles, including therein every description of railway, either public or private, an amount somewhat exceeding his former estimate, and derived mainly from the construction of lines not at that time in progress.

He then proceeded to give an estimate from the information that he had collected of the progress of these works during the next three years, ending at the termination of 1855; admitting, however, that the same accuracy was not as attainable as in the former estimate, inasmuch as that the period would be greater, and many contingencies which might affect the result could not be made the subject of calculation; the amount, however, he estimated at 18,900 miles at the minimum, and might attain at the maximum 19,700 miles, and even reach 20,000 miles if the bills now before Congress, in aid of Iowa and Missouri, should become law, and provided no commercial convulsion should create a stringency in the money market.

He then described the vast army of laborers on these works, and the various establishments directly or indirectly connected with them, as one of the great causes of the rise in the price of food, the others being emigration to California, the unprecedented immigration to this country from the great swarming hive of Europe, and the unprecedented increase of our urban population in a great measure attributable to this immigration, and the activity of commerce consequent thereon, and the result moreover in a great degree of these very railways, plank roads, canals, and steam navigation. The high price of provisions was thus enhanced on the one hand, and on the other prevented rising still higher by one and the same set of causes, which are likely still to continue for some time in operation. The drought of the last year and the unusual cold of the present, could but partially account for this rise.

In speaking of the density of population already attained in some parts of the United States, Mr. Smith referred to a map which he had constructed, which presented a curious illustration of this density. He traced the boundary of an area as large as the kingdom of Great Britain, as follows: commencing on the Atlantic at the mouth of the St. Croix river, ascending it to the head; from this point a line was drawn to the Saco, where it debouches from the White Mountains in New Hampshire, thence to Sandy Hill on the Hudson, in New York; thence to Oswego on Lake Ontario, including all south of it in New York, and all of New Jersey, Pennsylvania, and Maryland, north of the Blue Mountains; along this Mountain to the Potomac in Maryland, thence by the latter river to Washington, D. C., thence by a straight line to New Haven on Long Island Sound, and thence by the sea to the place of beginning in Maine. The included area will be 84,000 square miles, a close approximation to the Kingdom aforesaid, and the population of this area at the present moment, including the usual increase since the last census, is 8,180,000 in round numbers, an amount equal to that of Great Britain at the accession of George III, and about one-third of that at the present day. The present inhabitants of the American area within the boundaries just mentioned, is *twice as great* as the *average* population to the square mile in Europe, and vastly greater than the population of eastern or northern Europe, although much less, of course, in comparison, than the British, French, German, Austrian, and Italian countries, &c.

A line drawn from Massachusetts Bay to the Potomac, almost in a straight line, passes through more numerous and more populous cities than can be found on a similar line of about 400 miles in extent, drawn